

ANNALS OF SURGERY

A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

EDITED BY
LEWIS STEPHEN PILCHER, M.D., LL.D.,
OF NEW YORK.

WITH THE COLLABORATION OF

| | |
|--|---|
| J. WILLIAM WHITE, M.D., LL.D., OF PHILADELPHIA, Professor of Surgery in the University of Pennsylvania. | SIR WILLIAM MACEWEN, M.D., LL.D., OF GLASGOW, Professor of Surgery in the University of Glasgow. |
|--|---|

SIR W. WATSON CHEYNE, C.B., F.R.S.,
OF LONDON,
Professor of Surgery in King's College.

VOLUME LXIII
JANUARY—JUNE, 1916

PHILADELPHIA
J. B. LIPPINCOTT COMPANY
1916

CONTRIBUTORS TO VOLUME LXIII

ARMITAGE, GEO. L., JR., M.D., of Chester, Pa.

ARMITAGE, H. M., M.D., of Chester, Pa.

ASHHURST, ASTLEY PASTON COOPER, M.D., of Philadelphia, Pa.

BALFOUR, DONALD C., M.D., Mayo Clinic, Rochester, Minn.

BARTLETT, WILLARD, M.D., of St. Louis, Mo.

BEHAN, R. J., M.D., of Pittsburg, Pa.

BOLLING, R. W., M.D., of New York.

BONN, HARRY K., of Indianapolis, Indiana.

BOORSTEIN, SAMUEL W., M.D., of New York.

BRYAN, ROBERT C., M.D., of Richmond, Virginia.

COHN, ISIDORE, M.D., of New Orleans, La.

COLEY, WILLIAM B., M.D., of New York.

COTTON, FREDERIC J., M.D., of Boston, Mass.

DA COSTA, JOHN CHALMERS, M.D., of Philadelphia.

DARRACH, WILLIAM, M.D., of New York.

DAVIS, BENJAMIN FRANKLIN, M.D., of Chicago, Illinois.

DEAVER, JOHN B., M.D., of Philadelphia.

DODGE, GEORGE E., M.D., of Tuscon, Arizona.

DOWD, CHARLES N., M.D., of New York.

DURANTE, LUIGI, M.D., of Rochester, Minn.

EASTMAN, JOSEPH RILUS, M.D., of Indianapolis, Indiana.

ELIOT, ELLSWORTH, JR., M.D., of New York.

ERDMAN, BERNHARD, M.D., of Indianapolis, Indiana.

FALK, HENRY C., M.D., of New York.

FAUNTLEROY, A. M., M.D., of Washington, D. C.

FERGUSON, L. M., M.D., of Pittsfield, Mass.

CONTRIBUTORS TO VOLUME LXIII

- FLINT, JOSEPH MARSHALL, M.D., of New Haven, Conn.
- FLUMERFELT, GERTRUDE, M.R.C.S. (Eng.), L.R.C.P. (Lond.), of Victoria, B. C.
- FRAZIER, CHARLES H., of Philadelphia.
- FREEMAN, LEONARD, M.D., of Denver, Colorado.
- GAUDIANI, VINCENT, M.D., of New York.
- GIBSON, CHARLES LANGDON, M.D., of New York.
- GINSBURG, NATHANIEL, M.D., of Philadelphia.
- GOODMAN, CHARLES, M.D., of New York.
- GOODMAN, EDWARD H., M.D., of Philadelphia, Pa.
- GREEN, NATHAN W., M.D., of New York.
- GREGOR, GILBERT D., M.D., of Watertown, N. Y.
- GREY, ERNEST G., M.D., of Boston, Mass.
- GUTHRIE, DONALD, M.D., of Sayre, Pa.
- HAUSSLING, F. R., M.D., of Newark, N. J.
- HENDERSON, MELVIN S., M.D., Mayo Clinic, Rochester, Minn.
- HENDRIX, B. M., Ph.D., of Philadelphia.
- HITZROT, JAMES MORLEY, M.D., of New York.
- HORSLEY, J. SHELTON, M.D., of Richmond, Virginia.
- HUBBARD, JOSHUA C., M.D., of Boston, Mass.
- JEFFERSON, GEOFFREY, M.S. (Lond.), F.R.C.S. (Eng.), of Victoria, B.C.
- JONES, JOHN F. X., M.D., of Philadelphia, Pa.
- LEE, BURTON J., M.D., of New York.
- LEWALD, LEON T., M.D., of New York.
- LEWISOHN, RICHARD, M.D., of New York.
- LONG, JOHN WESLEY, M.D., of Greensboro, N. C.
- LOWER, WILLIAM E., M.D., of Cleveland, Ohio.
- LYLE, HENRY H. M., M.D., of New York.
- MACCARTY, WM. CARPENTER, M.D., of the Mayo Clinic, Rochester, Minnesota.

CONTRIBUTORS TO VOLUME LXIII

- MARTIN, WALTON, M.D., of New York.
- MARTLAND, H. S., M.D., of Newark, N. J.
- MATHEWS, FRANK S., M.D., of New York.
- MAYO, CHARLES H., M.D., of Rochester, Minnesota.
- MCCARTY, FRANKLIN B., M.D., of Chicago, Illinois.
- MCWHORTER, JOHN L., of New York.
- MCWILLIAMS, CLARENCE A., M.D., of New York.
- MEYER, WILLY, M.D., of New York.
- MOORE, JAMES E., M.D., of Minneapolis, Minn.
- MOSCHCOWITZ, ELI, M.D., of New York.
- MOULLIN, C. MANSELL, M.D. (Oxon.), of London.
- MURRAY, R. W., F.R.C.S., of Liverpool, England.
- NEUHOF, HAROLD, M.D., of New York.
- PEET, MAX M., M.D., of Philadelphia.
- PETERKIN, SHEARMAN G., M.D., of Seattle, Washington.
- PIPER, EDMUND B., M.D., of Philadelphia.
- POOL, EUGENE H., M.D., of New York.
- POPE, SAXTON, M.D., of San Francisco, Cal.
- PRIME, FREDERICK, of New York.
- QUILLIAN, GARNETT W., M.D., of Atlanta, Ga.
- REMSEN, CHARLES M., M.D., of Atlanta, Ga.
- RHODES, GOODRICH B., M.D., of Cincinnati, Ohio.
- ROBERTS, JOHN B., M.D., of Philadelphia.
- ROBINSON, ERNEST F., M.D., of Kansas City, Mo.
- ROCKEY, A. E., M.D., of Portland, Oregon.
- ROGERS, ALLEN, Ph.D., of Brooklyn, N. Y.
- ROSENBERGER, RANDLE C., M.D., of Philadelphia, Pa.
- SEKIGUCHI, SHIGEKI, M.D., of Japan.

CONTRIBUTORS TO VOLUME LXIII

SHAW, HARRY A., M.D., of Seattle, Wash.

SHROPSHIRE, COURTNEY W., M.D., of Birmingham, Ala.

SKILLERN, PENN G., JR., M.D., of Philadelphia.

SLOCUM, MORRIS A., M.D., of Philadelphia.

SMITS, J. C. J. C., M.D., of Sumatra.

SPEESE, JOHN, M.D., of Philadelphia.

SWEET, J. E., M.D., of Philadelphia.

TROELL, ABRAHAM, M.D., Stockholm, Sweden.

WALKER, M. H., JR., M.D., of Pittsfield, Mass.

WATTERSTON, CHAS., M.D., of Birmingham, Ala.

WIGHT, J. SHERMAN, M.D., of Brooklyn, N. Y.

WILLIAMS, HADLEY, F.C.R.S. (Eng.), of London, Canada.

ANNALS *of* SURGERY

VOL. LXIII

JANUARY, 1916

No. 1

GAS BACILLUS INFECTION

BY A. M. FAUNTLEROY, M.D.

OF WASHINGTON, D.C.

SURGEON U. S. NAVY

It has been rightly suggested that the term "gas gangrene" is a misnomer, in that it does not convey a scientifically correct etiological or pathological idea as regards the nature of this condition. As a substitute, the term "gas infection" has been used by many as being more appropriate, since it expresses more accurately the general character of a process in which a number of factors have to be considered in order to arrive at a correct understanding of the condition.

The infection of wounds by gas-producing organisms is by no means a new condition. Attention has been repeatedly called to infections in previous wars which have resulted in an emphysematous condition of the tissues; while the anaërobic character of the organisms involved has been recognized for a number of years. In the present war, the nature of the battle-ground, the concentration of large numbers of individuals, and the underground methods of warfare have all combined to accentuate the presence of this infection and caused it to assume a prominent role in present-day military surgery.

The Welch bacillus has been long known as an anaërobic gas-producing organism, capable of infecting wounds, and causing more or less serious complications. Until the outbreak of the present war, surgeons and bacteriologists have not had sufficient experience to justify a positive opinion, as regards the etiological relationship of this and other gas-forming organisms, in the production of what has been called "gas gangrene." The reason for this reservation has been due to the fact that numerous other organisms have been almost invariably recorded as accompanying an infection of this kind; and also due to the fact that certain heretofore unidentified organisms, resembling the Welch bacillus, were seemingly also causative factors. In addition to this, chains of cocci organisms have been thought at times to have been able to assume a gas-producing role. The other organisms

which have been found in gangrenous tissues and discharges, where gas has been present, are the colon, proteus and other putrefactive bacilli.

For several months after the present European war began the unidentified gas-producing bacilli, resembling the Welch bacillus, were known as the bacillus "perfringens," on account of certain cultural peculiarities which seemingly could not be reconciled with the cultural characteristics of the Welch bacillus. However, as time went on and the bacteriological technic of war hospital laboratories was more perfected, it became more and more apparent to careful observers that the perfringens was really a strain of the Welch organism; and, at the present time, laboratory men of large experience are practically unanimous in pronouncing them identical. The first definite case in which the bacillus was isolated from the blood, sufficiently early after death to completely establish its etiological role, occurred at the American ambulance during the early part of the present year. At this time, a culture of the heart's blood, three hours after death, gave a pure culture of *B. perfringens*. Since that time, instances have multiplied in which the same organism has been isolated from the blood during life in seriously infected cases. Not infrequently a pure culture has been obtained from the wounds of undeniable clinical cases and the condition reproduced clinically in guinea-pigs after the tissues of the latter had been injured. Only after previous injury to the tissues of the guinea-pig could the progressive gangrenous condition be produced. At the Pasteur Institute it was said that an injury to the guinea-pig's muscle was sufficient trauma to cause reproduction of the process.

Etiology.—As regards the conditions which are favorable for gas bacillus infection of wounds, it is to be noted that the *B. perfringens* has been found in the culture from many cases which present no clinical evidence of this form of specific infection. In fact, it is most unusual in base hospital work to examine the discharges from a wound and not be able to find the *B. perfringens* associated with either the staphylococcus, streptococcus or other organisms. Its practically universal presence in the discharges and tissues of all wounds of the present war, which show any signs of infection, would seem to indicate that the conditions for bringing about an infection with this organism are easily accomplished. That this organism flourishes in the soil, and is to be found in every locality where the present trench warfare is conducted, leads to the belief that the primary source of infection is in the dirt from the trenches in which the combatants are forced to live for days. The organism has been many times demonstrated in the outer clothing of soldiers, so that it is easy to understand its presence in wounds where

GAS BACILLUS INFECTION

bits of clothing are to be found. The soldier invariably comes from the trenches or dug-outs in a muddy or dusty condition, which latter is due to prolonged and intimate contact with the soft and oftentimes rain-soaked earth. Under these circumstances, even when clothing is not present in the wound, it is an easy matter for the omnipresent *B. perfringens* to ultimately find its way into the skin openings.

The very fact that the organism finds such easy access to all wounds, and also apparently finds in the latter a suitable culture medium without always manifesting itself, suggests the necessary presence of other conditions, notably in the wound, before it begins to exhibit its virulency as regards specific gas infection. The pathology of the lesions which show clinical signs of this condition is generally of a uniform character. Invariably there is more or less pulpification of the tissues, associated usually with fracture of the bone, and there is evidence in every case of more or less circulatory disturbance. This latter may manifest itself by a frank blood-vessel injury, which of necessity would interfere with the nutrition of the part, or there may be evidence after some days of thrombosis, inflammatory swelling, and slight œdema or skin mottling, any of which would indicate a certain degree of embarrassment to the nutrition of the part. There is some dispute as to whether the injury of a large blood-vessel is one of the necessary factors for the development of a clinical case. Whether this is true or not, it would seem to be essential for the growth and progressive virulency of the organism that a certain amount of devitalized tissue be present in the wound. The organism unquestionably thrives best in the presence of necrotic material, whether this necrosis be due to a limited pulpification, with or without injury to a large blood-vessel, or whether the subsequent sloughing be due to a secondary interference with the circulation.

A fatal case of gas bacillus infection is one that has passed through the progressive steps of (1) injury, (2) infection, (3) localized necrosis, (4) progressive gas production, (5) circulatory disturbance, (6) increased virulence, and, last, septicæmia. By timely and proper surgical measures, the progress of the process may be arrested and eventually cured; or the open character of the wound may be originally such as to render the essential anaërobic growth of the organism a difficult matter. Thus it is that one may see various degrees of gas bacillus infection depending upon character of the wound, time and nature of the surgical interference, and efficiency of the after-treatment.

Pathology.—Besides the extensive destruction and necrosis of the tissues immediately adjacent to the wound, there is marked parenchy-

matous degeneration of the muscles above and below the wound, and more or less marked cedematous infiltration interspersed with gas bubbles of varying sizes. The toxins formed by the *B. perfringens* would seem to exert a special selective action on the planes of connective tissue, since it has been often noted at operation and at autopsy that the necrosis has travelled with apparent greater rapidity along the fascial planes, which latter are often found to be much more extensively necrotic than the adjoining muscular tissue. The resistance of the tissues surrounding the wound is thus progressively lowered, and the subsequent necrosis increases the activity of the organisms, so that a vicious circle is rapidly established in which necrosis follows bacterial activity while the latter increases and becomes more virulent as a result of the necrosis. The outer walls of the blood-vessels in the immediate neighborhood of the infective process are also apparently specifically acted upon by the toxins, and this very probably accounts for the extravasated blood so often seen beneath the skin, or in the adjacent tissues, which in turn gives rise to the superficial mottling or discoloration.

Externally, the appearance of a gas-bacillus infected limb depends on the stage and degree of infection. In the earlier stages nothing is usually apparent, beyond the nature of the wound, to indicate the gravity of the process. In from two to five days, however, in those cases in which the process is following the stages already indicated, there is apparent a certain though small degree of swelling; palpation will usually elicit the presence of gas in the tissues, as indicated by the crepitation, and there is also usually to be noted the loss of a certain degree of tissue elasticity almost resembling induration; a slowly progressive brownish or copper-colored mottling of the skin adjacent to the wound; a more or less characteristic and marked fetid odor, resembling somewhat the pungent, sweetish stench of dead fish; the discharge from the wound, unless there is a mixed infection, is usually of a thin serosanguinous character which is not infrequently mud-colored; and, last, the more or less sudden appearance of crops of vesicles which vary in size from that of a pea to several inches in diameter. Although a pulse may be noted in one of the arteries distal to the wound, during the earlier stages of the infection, it becomes progressively weaker and in the last stage is always absent.

The fluid in the vesicles or blebs is of a serosanguinous character and not infrequently straw-colored. Rather rarely the fluid will show the presence of *B. perfringens*, but in most instances no bacillary infection will be found, although the staphylococcus is not infrequently present. An examination of the deeper infiltrating serous fluid in-

GAS BACILLUS INFECTION

variably shows the presence, rarely in pure culture, of the characteristic bacillus. In some of the fatal cases the infection rapidly travels up the limb and makes its emphysematous appearance in the tissues of the abdominal or chest wall. In certain cases involving the lower extremity the local tissue changes seemed to have been arrested at Poupart's ligament, although the blood was later found to be full of bacteria. In all fatal cases, the heart and larger blood-vessels of the body and brain were found to contain large numbers of gas bubbles. Aside from the septicæmic process, the presence of so much gas in the blood stream probably is the dominant factor in the almost sudden deaths to be noted in certain of the rapidly progressive fatal cases.

Under certain circumstances, the infective process becomes circumscribed to a varying extent. When this occurs it is thought to be largely due to the presence of a mixed infection, notably staphylococcus or pyocyaneus contamination. Aside from the surgical procedures which may have been instituted, it would seem that the occurrence, at an early stage, of these mixed infections may account for the protecting wall of leucocytes which forms and generally prevents an extension of the infective process. While tissue resistance undoubtedly plays a part in limiting or retarding the spread of this condition, the age and general vitality seem to have little, if any, influence in determining the outcome. The robust young patient, unless promptly and efficiently treated, falls as easy a victim as a less vigorous or older man.

Symptoms.—The signs of gas bacillus infection depend upon the pathological stage of the invasion. The symptoms which characterize the successive stages have a direct relation, first, to the character of the wound, as regards size, situation and degree of trauma; second, to the time elapsing between the reception of the injury and the institution of efficient surgical intervention; and, third, the care with which the after-treatment is conducted. Any one of these circumstances may not only have a decided influence on the progressive nature of the process, but is responsible in large measure for the intensity of the manifestations in the different stages and the virulence or activity of the infective organisms.

Gas bacillus infection, and the subsequent evolution of the respective stages, is almost necessarily confined to wounds of the extremities; for the reason that the same degree of trauma and deep destruction of tissue, which always precedes a spreading infection of this nature, would almost invariably prove quickly fatal if applied to any other part of the body, such as the head, neck, chest or abdomen. While mutilating wounds of the face, and large or small superficial wounds

elsewhere, may show the presence of *B. perfringens* at one time or another, nevertheless, the anaërobic and other general conditions for its favorable propagation or activity are usually lacking, and consequently there is very rarely an indication of an active invasion. For practically the same reason wounds of the hands rarely give evidence of the specific gas bacillus infection. Here the tissues are compact but not thick, so that there is relatively very little depth to the wound, and as a consequence aërobic, rather than anaërobic, conditions prevail. Deep wounds of the buttocks are especially prone to gas bacillus infection, and next, in the order of preference, is the thigh, leg, arm, forearm and foot.

Clinically, the first three *stages* of gas bacillus infection, namely, *injury*, *infection*, and *localized necrosis*, are grouped together for the reason that they are so inter-related, as regards the invasion, as to form practically a distinct entity with reference to the onset of symptoms, and these three stages represent the first clinical *grade* of gas bacillus infection. The reception of an injury, sufficiently severe to predispose to gas bacillus infection, is always accompanied at first by more or less shock, the degree of which depends upon the damage to the tissues and the attendant loss of blood. Either the infective organisms are driven into the wound with pieces of clothing or dirt, or else they invariably enter the wound after a very short time, and thus find in a deep wound, the character of which has already been indicated, the suitable media and anaërobic conditions upon which they thrive. The invasion of the organisms does not immediately become manifest, so that the first indications of a constitutional involvement, after reaction from the shock, would be the sapræmia due to the absorption of tissues but slightly removed from the normal, such as blood-clot or serum. Within a few hours after injury, the localized necrosis of the sides of the wound, though not apparent to the naked eye, would be present as the result of the severe traumatism inflicted upon the tissues in the path of the projectile. Although up to this point the specific activity of the gas bacillus cannot be demonstrated, it may be stated with certainty that by the time localized necrosis has become even microscopically manifest, the organism has begun its invasion.

The group of symptoms included under the general headings of shock, reaction from shock, and sapræmia are what might be called the prodromal symptoms of the invasion. The slight febrile manifestation of the sapræmia continues on into the slight fever which is due to the absorption of the newly-formed toxins of the infective organisms. Thus, in from ten to thirty hours after the injury, the mani-

GAS BACILLUS INFECTION

festations of the specific invasion are apparent. These manifestations are a fever of one or two degrees accompanied by a rising pulse-rate, slight headache, malaise, anorexia and moderate thirst. If the part is splinted and protected the patient does not complain of pain at this time. At this early stage there is no apparent enlargement of the wounded part, although a scant serosanguinous discharge is present and, if carefully examined, will show the *B. perfringens*. The odor of the discharge at this time has begun to assume the characteristic fetid trait. Gas formation has also begun, although the characteristic "crackling" beneath the skin on palpation is rarely elicited at this time. Its presence in the tissues can be demonstrated by opening up the pockets in the depth of the wound which will cause the perceptible escape of a certain amount of gas. Ofttimes in shaving the part at this time, a slightly resonant note will be apparent, as if shaving over a tight membrane. A faint brownish discoloration will usually be seen in the skin immediately adjacent to the wound. The tension in the tissues of the limb would seem to be increased in that there is a slight resistance imparted to the fingers during palpation. Some of these symptoms appear later than others, but, as a rule, within forty-eight hours, and usually much less, all the manifestations indicated are present.

It is during this early part of the invasion that the abortive treatment gives excellent results. Usually up to twenty-four hours the invasion and the tissue changes are not so far advanced but that vigorous methods of wound sterilization can be successfully carried out. After this time the changes are more pronounced, although up to forty-eight hours the condition has usually not progressed to such an extent as to give evidence of the more serious stages. From about forty-eight hours on, the more or less rapid progress of the infection is in direct proportion to the lapse of time.

The second grade of gas bacillus infection is represented by the succeeding three stages already mentioned, namely, *progressive gas production*, *circulatory disturbance*, and *increased virulence*. These three stages are likewise grouped together on account of their clinical inter-relation. This grade of the infection begins to appear usually after about forty-eight hours, in the average run of untreated or inadequately treated cases. This grade extends usually from about forty-eight hours up to four, five or six days, dependent upon the size and condition of the wound, the severity of the infection, the general resistance of the patient, and the character of any previous surgical treatment. If the condition has not been thoroughly treated during the first grade, the manifestations of the second grade make their appear-

elsewhere, may show the presence of *B. perfringens* at one time or another, nevertheless, the anaërobic and other general conditions for its favorable propagation or activity are usually lacking, and consequently there is very rarely an indication of an active invasion. For practically the same reason wounds of the hands rarely give evidence of the specific gas bacillus infection. Here the tissues are compact but not thick, so that there is relatively very little depth to the wound, and as a consequence aerobic, rather than anaërobic, conditions prevail. Deep wounds of the buttocks are especially prone to gas bacillus infection, and next, in the order of preference, is the thigh, leg, arm, forearm and foot.

Clinically, the first three *stages* of gas bacillus infection, namely, *injury*, *infection*, and *localized necrosis*, are grouped together for the reason that they are so inter-related, as regards the invasion, as to form practically a distinct entity with reference to the onset of symptoms, and these three stages represent the first clinical *grade* of gas bacillus infection. The reception of an injury, sufficiently severe to predispose to gas bacillus infection, is always accompanied at first by more or less shock, the degree of which depends upon the damage to the tissues and the attendant loss of blood. Either the infective organisms are driven into the wound with pieces of clothing or dirt, or else they invariably enter the wound after a very short time, and thus find in a deep wound, the character of which has already been indicated, the suitable media and anaërobic conditions upon which they thrive. The invasion of the organisms does not immediately become manifest, so that the first indications of a constitutional involvement, after reaction from the shock, would be the sapræmia due to the absorption of tissues but slightly removed from the normal, such as blood-clot or serum. Within a few hours after injury, the localized necrosis of the sides of the wound, though not apparent to the naked eye, would be present as the result of the severe traumatism inflicted upon the tissues in the path of the projectile. Although up to this point the specific activity of the gas bacillus cannot be demonstrated, it may be stated with certainty that by the time localized necrosis has become even microscopically manifest, the organism has begun its invasion.

The group of symptoms included under the general headings of shock, reaction from shock, and sapræmia are what might be called the prodromal symptoms of the invasion. The slight febrile manifestation of the sapræmia continues on into the slight fever which is due to the absorption of the newly-formed toxins of the infective organisms. Thus, in from ten to thirty hours after the injury, the mani-

GAS BACILLUS INFECTION

festations of the specific invasion are apparent. These manifestations are a fever of one or two degrees accompanied by a rising pulse-rate, slight headache, malaise, anorexia and moderate thirst. If the part is splinted and protected the patient does not complain of pain at this time. At this early stage there is no apparent enlargement of the wounded part, although a scant serosanguinous discharge is present and, if carefully examined, will show the *B. perfringens*. The odor of the discharge at this time has begun to assume the characteristic fetid trait. Gas formation has also begun, although the characteristic "crackling" beneath the skin on palpation is rarely elicited at this time. Its presence in the tissues can be demonstrated by opening up the pockets in the depth of the wound which will cause the perceptible escape of a certain amount of gas. Ofttimes in shaving the part at this time, a slightly resonant note will be apparent, as if shaving over a tight membrane. A faint brownish discoloration will usually be seen in the skin immediately adjacent to the wound. The tension in the tissues of the limb would seem to be increased in that there is a slight resistance imparted to the fingers during palpation. Some of these symptoms appear later than others, but, as a rule, within forty-eight hours, and usually much less, all the manifestations indicated are present.

It is during this early part of the invasion that the abortive treatment gives excellent results. Usually up to twenty-four hours the invasion and the tissue changes are not so far advanced but that vigorous methods of wound sterilization can be successfully carried out. After this time the changes are more pronounced, although up to forty-eight hours the condition has usually not progressed to such an extent as to give evidence of the more serious stages. From about forty-eight hours on, the more or less rapid progress of the infection is in direct proportion to the lapse of time.

The second grade of gas bacillus infection is represented by the succeeding three stages already mentioned, namely, *progressive gas production*, *circulatory disturbance*, and *increased virulence*. These three stages are likewise grouped together on account of their clinical inter-relation. This grade of the infection begins to appear usually after about forty-eight hours, in the average run of untreated or inadequately treated cases. This grade extends usually from about forty-eight hours up to four, five or six days, dependent upon the size and condition of the wound, the severity of the infection, the general resistance of the patient, and the character of any previous surgical treatment. If the condition has not been thoroughly treated during the first grade, the manifestations of the second grade make their appear-

ance, as regards promptness and severity, in indirect proportion to the efficiency of the early surgical treatment. As the large base hospitals do not receive their patients until usually four or five days have elapsed, there is usually evidence in these cases of advanced second grade manifestations, because of the fact that the onset of this grade has occurred during the more or less prolonged journey to the hospital.

Not a little confusion has arisen, as regards the general description of what has been known as "gas gangrene." Some observers have described a condition which has been almost entirely unlike the experience of others. The reason that this occurs is due to the fact that different grades of the same condition have been described by different writers and the general process was not considered as a whole. The experience of a surgeon whose work has been comparatively near the front and where he has only had to deal with the first grade is at variance with the experience of another surgeon whose observations, in a base hospital further to the rear, deal entirely with the second or third grade of the infection. Hence it is that varying accounts of the same condition have appeared and given rise to doubt in the minds of many as to the exact nature of the process.

The onset of the second grade is usually characterized by a more or less pronounced increase in the pulse-rate, which appears to be out of all proportion to the temperature. The latter is at first only slightly raised, but, as the toxic products of the wound become more rapidly absorbed, the temperature begins to mount and may reach 104° or 105° F., in from ten to twenty hours. The discharge from the wound is now frankly and characteristically fetid. If a mixed infection has occurred, which is usually the case, the thin serosanguinous discharge is augmented by the presence of pus. The progressive elaboration of gas, which has already begun, can now usually be detected by the crepitation or "crackling" in the tissues when the latter are palpated. The brownish mottling or discoloration of the skin near the wound is much more distinct than in the first grade and shows a tendency to spread. The swelling of the part is now distinctly apparent and the tissues in the neighborhood of the wound are slightly indurated, showing decided evidence of circulatory disturbance. Acute pain in the wound is now complained of, and it is not unusual for a severe pain to manifest itself in the lumbar region. The headache, anorexia, malaise and restlessness are marked, and the facial expression assumes a dull, stupid character. These symptoms are all of a progressive character, lasting over a variable period of from one to three days, and this progressive nature of the symptoms indicates the *increased*

GAS BACILLUS INFECTION

virulency of the infective process. During this time, or possibly a few hours later, small successive crops of vesicles begin to appear on the skin adjacent to the wound and may increase in size and number. When the symptoms of the second grade are well advanced, unless prompt measures are instituted, the patient begins to sink into a fitful coma-like condition which heralds the approach of the third and final grade, which is septicæmia.

The insidious onset of the third or *septicæmic grade* is characterized by a deepening of the stupor which has begun to make its appearance during the latter part of the second grade. There is now usually a rapid display of grave manifestations, which characterize an overwhelming infection and the invasion of the blood-stream by the infective organism. The ominous sign of a falling temperature with a rising pulse-rate makes its appearance. The apathetic stupor, the shallow and jerky respirations, the loss of body temperature, the rapid and thready pulse, all bespeak the approaching end. Occasionally, in those cases that linger for a longer period, there is a typhoid-like manifestation which is characterized by a whispering delirium, the so-called "coma vigil," carphologia, a transient half awakening or feeble restlessness, and a steady decline of both heart and respiration. In some cases death occurs within a very short period after the onset of the third grade. Sometimes within an hour the patient will rapidly sink and suddenly expire. This latter suggests the lethal presence of another overwhelming factor besides the septicæmia. As already indicated, this may be attributed to the rapid liberation of a large amount of gas in the blood-stream.

Diagnosis.—The diagnosis of gas bacillus infection resolves itself into a recognition of the progressive nature of the process. In view of the fact that it is almost certain that every wound in the present trench warfare which shows the slightest sign of infection is contaminated by the presence of the gas bacillus, practically every open wound under the present conditions must be regarded from the very beginning as potentially a gas bacillus infection. The only exceptions to this rule are those perforating bullet wounds which do so little tissue damage that they usually heal spontaneously. Even these wounds are not to be regarded too lightly, but must be treated expectantly for at least three days, as there is no immunity in any wound inflicted under the present war conditions. As already indicated, infection in some form is universal in every open wound of the present trench warfare, as statistics will show; and while the *B. perfringens* does not proclaim its presence in a certain percentage of these cases, nevertheless, a careful bacteriologi-

cal examination of the discharge is invariably positive. Under these circumstances a clinical diagnosis of the first grade of gas bacillus infection cannot be said to be demonstrable in every case of early infection that shows the latent presence of the gas bacillus. While the surgical treatment takes into consideration its more than probable future activity, yet a diagnosis of the first grade is tentatively withheld until there is evidence of the progressive manifestations already indicated.

It is true that other infections, which are improperly treated, show certain signs of progression; nevertheless, the progressive nature of these infections presents a different picture to the indications of gas bacillus infection. The latter infection is not only progressive at a much earlier period than any other known forms of wound infection, but its steady progress is characterized by an accentuation of certain features which are peculiar to gas infection, namely, the *localized necrosis*, the almost characteristic *odor* and the slight *skin discoloration*. In addition to this, the thin serosanguinous discharge manifests itself within a few hours after active gas bacillus infection, in response to the activity of the organism and its toxin in the depth of the wound; while in the usual forms of other wound infections the characteristic discharge or pus is not evident for a much longer period. The rising pulse-rate which is usually out of proportion to the degree of fever, while by no means pathognomonic of the first grade of gas bacillus infection, nevertheless is highly suggestive in view of the usual febrile response to other wound infections in which the rapidity of the pulse is usually in direct proportion to the degree of fever.

The diagnosis of the second grade of gas bacillus infection presents no real difficulties in view of the progressive nature of the process. Here, the cardinal signs of beginning gas bacillus infection, namely, the *necrosis*, *odor* and *skin discoloration*, are all accentuated. In addition, there is the usual crepitation in the tissues, as a result of the *progressive gas formation*; the swelling and slight local induration, to indicate *circulatory disturbance*, and the usual sharp rise of temperature, in connection with the increased pain and other minor symptoms, to indicate an *increased virulence* of the infection. Since a mixed infection is usually present by the time the second grade is reached, a consideration of this complication, when present, shows a thick yellow or greenish pus, which latter has a bluish tinge in case the contaminating organism is *B. pyocyaneus*. There is usually the further evidence of a more decided reaction in the tissues, as indicated by the more or less œdema. The behavior of the temperature would be somewhat different in that

GAS BACILLUS INFECTION

the rise would generally be gradual from the date of the mixed infection, instead of spasmodically high as is the usual result of an increased virulence on the part of the gas bacillus. In view of a sudden rise in the temperature, pneumonia or pleurisy must not be overlooked and, once thought of, can easily be confirmed or excluded.

As regards the diagnosis of the third grade of gas bacillus infection, there is no essential difference between this grade and the septicæmia caused by the presence of pyogenic cocci in the blood-stream. It may be said that gas bacillus septicæmia appears to be somewhat more progressively asthenic in character than other forms, and that it is apparently complicated at times by the presence of an excess of gas in the blood-stream.

Prognosis.—The prognosis of gas bacillus infection, like other factors considered in describing this condition, has to be regarded from the view-point of the progressive nature of the process. The three progressive grades of this condition present a progressively grave outlook as regards the conservation of tissues and the restoration of health. While the grouping of the progressive stages into three successive grades is a somewhat arbitrary, although decidedly convenient, division of the process; nevertheless, it is also justified and thoroughly warranted by the clinical behavior as a whole. Like other infectious processes, there is of necessity a continuity between the subdivisions which represent the individual clinical aspects of the condition, and, by the same token, it must be remembered that there is no sharp line of demarcation between the three grades. For this reason, in order to arrive at a correct understanding of the clinical outlook of the three grades, it will be necessary to consider the separate, though hyphenated, stages which constitute the process as a whole. In order to emphasize the clinical aspects of this condition, and the grouping of the stages into grades, attention is invited to the following tabulated arrangement which shows the grades subdivided into the successive stages.

| First Grade | Second Grade |
|----------------------------|--------------------------------|
| 1. Injury. | 1. Progressive gas production. |
| 2. Infection. | 2. Circulatory disturbance. |
| 3. Localized necrosis. | 3. Increased virulence. |
| Third Grade Septicæmia. | |

The first stage, that of injury, has a direct bearing on the future progress of the infection. If the wound is large, ragged and deep it affords the ideal condition for quick infection and rapid dissemination. The situation of the wound also influences the nature of the process.

If the wound, by reason of its anatomical location, has injured one or more large blood-vessels and nerves, the nutrition of the part is proportionately quickly embarrassed and the rapid death of the entire member may ensue. Under these circumstances, the massive death of the tissues as a whole, known as gangrene and usually of the moist variety, is substituted for the classical progressive localized necrosis which characterizes a purely gas bacillus infection. On the other hand, if the wound, though deep and ragged, has not injured the important nutritive and trophic tissue elements, its subsequent relation to the infective process depends upon certain selective localities. As already indicated, the buttock seems to be more quickly and universally susceptible to gas bacillus infection than any other part of the body. Next in importance would be the deep, narrow and destructive wounds of the thigh. The same character of wounds in the leg would seem to follow as a selective sequence, while a destructive wound of the arm or forearm comes next in the order mentioned. Although certain other localities, already mentioned, have been known to exhibit signs of gas bacillus invasion, yet on account of the thinness of the structures involved it rarely manifests itself. The degree of traumatism, as a prognostic factor, is partially considered above, but, on account of the known preference of the gas bacillus for pulpified and subsequently necrotic tissue, this factor, as regards the rapid progress of the infection, is in direct proportion to the local devitalizing extent of the traumatic process.

The next feature of prognosis as regards the injury is the time elapsing between the reception of the injury and the institution of efficient surgical procedures. The longer the wounded remain without thorough surgical attention, the more certain will the infective process become firmly and progressively established. As Carrel has said, the general fate of the wounded is dependent upon the quickness with which they can be transported to hospitals where adequate attention is provided. The thoroughness of the surgical intervention is also a weighty factor in the progress of the infection. Haphazard and inadequate measures are responsible not only for a false sense of security in regard to controlling the progress of the infection, but also culpably involved in the serious and oftentimes fatal delay in the proper treatment of the wound, resulting from a lack of thorough surgical technic at a time when the process could be more certainly controlled. Once that thorough surgical measures have been instituted, the next factor, as regards the future welfare of the injury, is the care with which the after-treatment is conducted. Unless painstaking thoroughness charac-

GAS BACILLUS INFECTION

terize the after-treatment not only is the process prolonged, thus subjecting the patient to the dangers which not infrequently arise from various complicating influences, but the ultimate result, as regards bone and other tissues healing, will be proportionately unsatisfactory.

The influence of the second stage, or stage of incipient *infection*, on the general prognosis of the process is likewise largely dependent on the promptness with which the wound can be thoroughly treated. The longer the delay, the greater the opportunity for the infection to spread and become more virulent. Prompt and efficient measures at this time will largely limit and oftentimes abort the specific process, and at the same time not infrequently prevent a mixed infection. As regards the latter, while it frequently occurs sooner or later under the usual conditions of war surgery, it always prolongs the general process and invariably vitiates the ultimate result. The longer it can be prevented, the healthier the wound will become; and the consequent increased tissue resistance causes a more favorable outlook, as regards throwing off any contaminating process, and thus establishing a more satisfactory convalescence. While a mixed infection does appear to indirectly limit to some extent the spread of gas bacillus infection by causing the usual protective wall of leucocytes to appear, nevertheless, it is a condition to be avoided, not only for the reasons already given, but because there are other and much better means of controlling the spread of the specific process.

The third stage, or *localized necrosis*, completes the first grade of the general process for the reason that all the conditions are now ripe for the specific organism to inaugurate its vicious circle and augment its virulency. The earlier the necrotic wall of the wound can be removed, the speedier the cessation of the infective process. The amount of necrotic material in the wound necessarily exerts a potent influence, and the larger the amount of necrosis present the more radical must the procedures be in order to overcome the tenacity of the infection. The first grade of the general process presents on the whole a decidedly hopeful prognosis in the light of our present knowledge. The bacteriological and pathological conditions being known, it is only necessary to put into practice the principles of treatment which are known to be effective in establishing as near as practicable a return to the normal. It is during this grade, before the organism has gained a firm foothold and increased its virulence, that the abortive treatment offers considerable hope of bringing about a rapid and uncomplicated convalescence.

The outlook for the second grade of the process is decidedly less hopeful in its general character than the first grade. This establish-

ment of the second grade means that the gas bacillus, not unusually accompanied by a contaminating organism, is now more or less firmly implanted in the tissues of the wound and has begun in earnest the operation of its vicious circle. While somewhat dependent upon the degree of thoroughness in treating the infection during the first grade, the prognosis of the second grade depends largely upon the degree of progression in the three individual stages which make up the second grade. The first of these stages, which is *progressive gas production*, indicates that the principal clinical by-product of the infection, and the one which gives to the process its name, is being manufactured under circumstances progressively favorable to the progress of the process. The rapid evolution of the gas in the tissues predisposes the latter to a more rapid dissemination of the infection, in that it stretches the tissues and opens up new avenues for an extension of the process. It sometimes happens that the gas is so confined in the tissues, by reason of being pocketed, and the tension is so increased, as to cause a distinct explosive sound when the pocket is incised or the dressings removed, if the latter has acted as a plug in the wound. Hence it is, the more rapid the evolution of the gas, the more rapid are the changes which follow closely upon this stage, and therefore the more unfavorable the outlook.

The second stage of this grade, namely, *circulatory disturbance*, is an important factor in the prognosis in that its manifestations are usually apparent to the unaided eye and thus afford a quick and reliable index as to the general condition of the underlying tissues. A circulatory disturbance means that the nutrition of the part is being hampered and that another link is being progressively forged which will increase the activity of the process. The indications of this disturbance have already been mentioned. The parts in the neighborhood of the wound become distinctly swollen and there is a slight indurated oedematous condition apparent in the tissues adjacent to the wound. These manifestations indicate that the circulatory system is struggling to overcome the unsatisfactory nutrition of the part caused partly by the devitalizing influence of the increased amount of toxin in the tissues, and partly by the increased tissue tension due to the spread of the process. While the copper-colored mottling of the skin in the neighborhood of the wound is more or less apparent from the very first grade of the process, nevertheless, this discoloration, being now influenced by the progressive circulatory disturbance, assumes a more decided brownish tint, which might be described as a brawny induration, and there is distinct evidence of its decided tendency to spread. This

GAS BACILLUS INFECTION

tendency of the discoloration to spread is in direct proportion to the extent of the circulatory disturbance, therefore the greater the disturbance, the more extensive the discoloration. This brawny discoloration can usually be easily detected and, when its progressive character is manifest, the gravity of the general prognosis is increased in proportion.

The third, or *increased virulence stage*, represents the climax of the second grade of the process. Its manifestations are closely associated with, and dependent upon, the preceding stage of circulatory disturbance. The progressive devitalization of the part, beginning with the localized necrosis in the walls of the wound, has now reached its culmination in the more extensive local death of the surrounding tissues. Once the resistance of these surrounding tissues is completely overcome, the rapid extension of the devitalization is assured and a fulminating character is imparted to the process. Besides the clinical evidence already mentioned, the increased virulence of the infective process is evident from the suddenly more extensive activity of the process and its rapid dissemination throughout the dying tissues. Hence it is that the massive death, which is now progressively occurring in the tissues surrounding the wound, has received the name of "gas gangrene." The most potent and continuous influence in causing this gangrenous process is undoubtedly the toxin elaborated by the infective organism. This toxin is the pivot in the vicious circle by means of which necrosis follows the elaboration of the toxin and bacterial activity is increased by the necrosis. The production of gas is only an incidental by-product in the process, and hence the term "gas infection" should also be discarded in that it does not express the true nature of the process. In view of the progressive character of the infection and its ability to create the conditions favorable for continuance of the process, the term "progressive emphysematous necrosis" would more accurately express the character of the condition and at the same time indicate its most prominent clinical manifestations.

The prognosis of the third, or *septicæmic*, grade of the process is exceedingly grave. It represents such an overwhelming degree of infection that all protective barriers have been swept away and the systemic invasion by the organism has occurred. As in other septicæmias, this lethal process is progressively asthenic in character but it would seem to be specially so in this particular form, which would also seem to indicate a total breaking down of all resisting power. Under these circumstances it is not surprising that almost sudden

deaths occur which may be hastened by the embarrassing presence of an unusually large amount of gas in the blood-stream.

Treatment.—The line of treatment to be adopted for this condition is to be considered under three distinct headings, according to the indications which are usually apparent as regards the invasion of any infective process. Thus there would be the prophylactic, the abortive, and the curative procedures.

The prophylactic procedures, as regards this infection, would seem to resolve themselves into the precautions which are more or less familiar to all, and which are the usual precautions against wound infection. Under the present circumstances of the trench warfare in Europe it would seem to be well-nigh impossible to obviate an exceedingly high percentage of wound infection, and especially infection with the organism responsible for the *progressive emphysematous necrosis*. The reasons for this are not far to find. In the first place, the entire western European war area has undergone for many years an intensive process of cultivation which has resulted in the soil being saturated with fertilizers and caused it to be the medium par excellence for harboring the infective organism. Once the trenches are dug deep in this soil, there is no escape from the ever-present conditions which are favorable for infecting every wound. Soldiers are obliged to occupy these trenches for days and nights consecutively under all weather conditions, so that their clothing and body surface become more or less permeated with the trench dust and dirt, which latter, of course, contains the infective organism in concentrated numbers.

A consideration of these facts leads to the theoretical conclusion that something might be accomplished in a prophylactic way by not only covering the floor of the trench with small fagots of wood, which is now the universal custom, but to make an effort at the disinfection of the sides of the trench. Calcium hydrate, or slaked lime, white-washed thickly and repeatedly along the sides of the trench could at least do no harm and doubtless would be productive of not a little indirect good. Besides being very cheap and easy to acquire in large quantities, it is a deodorant and possesses distinct antiseptic properties.

The sides of the trenches are frequently lined by upright stakes interlaced with cross-wise pieces of thin wood in order to prevent the crumbling dirt from falling into the trenches. This arrangement would be more favorable for the application of the white-wash than when the sides of the trench are unprotected, although, under the latter circumstances, once the dirt is hard and dry it would be no great difficulty to keep a thick covering of lime on the trench walls. There could be

GAS BACILLUS INFECTION

no military objection to this, as it would not be visible to the enemy under ordinary circumstances. Small sections of the trenches are covered over to some extent all along the line, and the positions of the opposing trenches are perfectly familiar to all combatants in the field, so that any added feature of trench hygiene, even though conspicuous, would not unduly expose the occupants to the enemy fire or cause enemy attention to be attracted any more than at present prevails. Cementing the wall of the trench has been done in selected places, but for a general application it is out of the question for many reasons.

There is something to be said about the clothing from a prophylactic stand-point. The French soldier's uniform and overcoat, which latter he wears continuously for some reason both winter and summer, is made of a thick, coarse, felty material which certainly becomes very easily more or less permanently contaminated with dirt. Body sweat and rain keep the clothing inundated for considerable periods, and this moisture in the fabric helps to maintain the vitality of any organisms which may be present in the dirt. The British soldier's uniform is composed of somewhat the same character of material, resembling a rather thick flannel. It would certainly be the part of wisdom, from the view-point of infection, to adopt a less porous and more easily cleansible type of uniform, such as khaki cloth which has a hard finish. In addition to the foregoing, cleanly habits and a rigorous policing of all trenches would of course be productive of general good.

The soldier should receive, as a necessary part of military training, repeated instructions in the rudiments of asepsis, antisepsis and the conditions favorable to wound infection. This would unquestionably not only lead to a more careful and intelligent application of the first-aid package, but would be conducive of far-reaching good as regards improving and avoiding the conditions favorable to infection. At the first-aid stations iodine should be freely used, pouring it into the wound and applying it to the surrounding surface. Carrel recommends the injection of Dakin's fluid into narrow wounds at this time and also dressing the large wounds with gauze saturated with the same solution.

The abortive treatment of this progressive infection contemplates being able to thoroughly treat the wound within twelve hours after the receipt of the injury. The earlier this treatment is begun, the better the outlook for accomplishing its purpose. The principles of this abortive treatment are twofold, mechanical and chemical. The mechanical process calls for the prompt and delicate removal of all foreign bodies, such as projectiles, fragments of clothing and unattached splinters of bone. It is necessary, in the vast majority of cases, to enlarge

the wound in order to thoroughly accomplish this important feature of the work. The X-ray is a valuable adjunct and should always be used when practicable. There should be as little traumatizing of the wound as is consistent with thorough surgical technic. All overhanging and ragged edges should be carefully trimmed and the wound should be thoroughly inspected to ascertain the presence of loose, ragged or apparently devitalized tissue. Pieces of fascia should be carefully removed and the sides of the wound left as smooth as possible. All bleeding should be thoroughly controlled at this time and the general extent of the damage ascertained.

The chemical part of the abortive treatment calls for the continuous application of an antiseptic which will not only promptly destroy the organisms with which it comes in contact, but which will dissolve or detach any pieces or areas of devitalized or necrotic tissue which happen to be left behind or develop afterwards in the wound. The Dakin fluid is such an antiseptic, and is not only highly germicidal but is practically non-irritative. As regards large wounds, the thorough application of this fluid is accomplished first by the introduction into the depth of the wound of long fenestrated narrow rubber tubes, the number depending on the size of the wound and the diverticula present. The object is to so place the tube or tubes that when fluid is injected through them and into the wound it will reach all parts. With the tubes in place, and projecting for four or five inches outside the wound, the latter is now lightly packed with gauze saturated with the Dakin fluid. Alcohol should not be used in conjunction with the Dakin fluid, as it causes the latter antiseptic to become irritative to the tissues by the rapid liberation of free chlorine. A layer of non-absorbent cotton, through which pass the rubber tubes, completes the dressing. The fluid is injected every one to two hours into the tubes or the latter may be coupled to a Murphy drip apparatus. The object is to keep the gauze in the wound thoroughly saturated with the fluid, but not cause it to leak from the wound. This is kept up sometimes for as long as forty-eight hours, depending upon the size and character of the wound. At the end of this time if the treatment has been thoroughly carried out, the wound will be sterilized in the great majority of cases. The wound is inspected and the dressings carefully renewed every morning.

In addition to the sterilization of the wound the abortive treatment also contemplates the use of some form of permanent dressing or an apparatus best suited to the special needs of the individual case. In case of a fractured bone the use of a carefully applied plaster dressing, either in the form of a fenestrated permanent cast or as a moulded

GAS BACILLUS INFECTION

splint, is recommended. Plaster is advocated for the reason that, as soon as the sterilization of the wound is assured, the patient can be transported to the rear much more easily and safely in this form of splint than in others. When the large hospital of the interior is reached the cast may be removed if thought necessary, and any form of special apparatus applied that will best suit the individual needs of the case. As regards the patient's transfer to another hospital, no case should be transported, except in an emergency, until the sterilization of the wound is complete. It has often occurred that the delays incident to prolonged travel have resulted disastrously for the patient when there is an active infection in the wound.

It has been the practice with a large number of surgeons, as regards the early general treatment of wounds, to open up the latter thoroughly; remove foreign bodies; irrigate with salt solution or an antiseptic; introduce drainage tubes; and either use a dry or wet dressing, according to the individual preference of the surgeon. Whether or not the surgical indications have always been conscientiously carried out, it is a fact that a very large number of wounds reach the base hospitals of the interior in a septic condition. This indicates that the early and subsequent treatment has not been thorough enough to prevent a continuance of the infection. The abortive treatment outlined above has been successfully used a large number of times, and there is every reason to believe that, when conscientiously applied, it will greatly improve the statistics of wound infection. It must not be lost sight of that in the abortive or any other line of treatment, one of the cardinal surgical indications is to produce aërobic conditions in the wound instead of anaërobic, which latter is the condition most suitable for a continuance of the infective process.

The curative treatment has especially to do with the second grade of the infective process, and it is this grade of the condition that has been usually treated in the large base hospitals of the interior for the reasons already given. This form of treatment either calls for a continuation of the treatment already instituted elsewhere, or the adoption of special procedures to meet any special demands. In the beginning, this treatment may be an intensified continuation of the abortive treatment outlined above, or it may take the form of any special surgical procedure individually preferred by the surgeon. The X-ray should always be made use of as a matter of routine to ascertain if any metal has escaped being removed in the previous treatment. It is usually a foreign body, either metal, cloth or bone, which is responsible for keeping up the infection in the earlier stages of the second grade. In

any case the wound should be thoroughly inspected and all pockets or diverticula opened up. Any necrotic material should be carefully trimmed away at this time and especially should necrotic or loose fascia be sought for. As this class of cases usually presents a mixed infection, it is more than likely that drainage tubes will have to be used to facilitate the drainage of pus. These tubes need not interfere with the use of the Dakin fluid as outlined above. Some operators may prefer to adopt a different line of treatment than the Carrel method, in which case it may take the form of any well-recognized surgical procedure. Dr. Wineberg, of the Pasteur Institute, has introduced a serum which has been tried out in a large number of different cases but so far no apparent results have followed its use.

After the case has been operated upon, the general and local conditions must be carefully watched. If the infection is being controlled, and improvement sets in, the temperature and pulse subside, the discharge becomes progressively less, the wound gradually assumes a healthy appearance and a satisfactory convalescence is established. If, on the other hand, the condition not only does not improve but shows indications of becoming progressively worse, certain radical measures must be contemplated with the idea of at least saving the patient's life. If the process involves the upper or lower extremity, amputation may be performed as a life-saving measure. This must not be undertaken too lightly, nor be too long delayed to reasonably insure saving the patient.

Sir Almroth Wright has recommended the placing of strips of gauze in the depth of the wound and in special incisions which are made with a view to reaching the deep fascial planes. These strips of gauze are kept more or less continuously saturated with salt solution, and the presence of the latter in the wound causes a certain amount of responsive outpouring of serum from the tissues. This treatment has been used with apparent success by a number of British surgeons and at the Japanese Red Cross Hospital. While this method of treatment may be satisfactorily used in selective cases, it is the opinion of quite a large number of surgeons, who have had considerable experience during the present war, that the great majority of progressive cases require a more radical treatment; such as not only a thorough opening up of the wound, but also the more or less continuous use of an active antiseptic.

Another method of treatment, which was enthusiastically endorsed by a few, consisted in the subcutaneous introduction of oxygen under pressure into the tissues above the wound. This method was reported as being in successful operation at a certain few hospitals, but it has been thoroughly tried out a number of times in other hospitals and the

GAS BACILLUS INFECTION

reports have been almost invariably to the effect that the procedure exerted very little influence, if any, upon the infective process.

The indications for amputation are largely a matter of surgical judgment and experience. A number of factors would have to be considered before arriving at a definite conclusion as regards the entire removal of a limb. It is during the latter part of the second grade of the progressive process, namely, during the stages of circulatory disturbance and increased virulence, that amputation comes up for serious consideration. It is because of the rapid local and constitutional changes at this period that the surgeon must be on his guard and prepared to act promptly in case a decision is reached. Familiarity with the pathology of the last two stages of the second grade of the process will alone enable the surgeon to form an intelligent opinion as regards the radical removal of the offending member. Consideration must be given not only to the local tissue changes, as manifested in the stage of circulatory disturbance, but the constitutional resistance must be carefully estimated at the stage of increased virulence. As already indicated, these two last stages of the second grade are so closely inter-related, and the process as a whole is so dependent upon the mutual and responsive reactions occurring between these two stages at this time, that the climax or crisis represents the culmination of the more or less rapid general changes which have taken place as the result of this intimate relationship between the two stages. The index of the critical point in the patient's condition is therefore the point where the local and constitutional manifestations have converged to form a picture of combined and acute distress.

Under these circumstances, the local manifestations which would call for removing the part would be the more or less rapid display of progressive tissue death, as indicated by the spreading discoloration, the increased oedematous induration and the manifest inability of the embarrassed circulation to reestablish itself in the swollen and tense member. At this time there would be a perceptible loss of temperature in the tissues below the wound and no appreciable evidence of a distal pulse or circulation.

The serious constitutional manifestations which follow closely the above local changes and which indicate an *increased virulence*, are those which show unmistakable evidence that the infective process is gaining a more or less rapid ascendancy over the body resistance. The temperature at first would begin its spasmodic or steady rise, the already disproportionately rapid pulse would further increase in rate, and the

patient would exhibit the dull and listless attitude towards his environment which shows the influence of a powerful depression.

In view of the combined evidence of a beginning progressive local and constitutional decline, the surgeon is thoroughly warranted in deciding upon an amputation. The latter must be performed with the utmost despatch, consistent with the recognized principles of good surgery. The stump should be left wide open and no effort made to limit the size of the wound by the introduction of sutures. This latter admonition is highly important in view of the paramount necessity of making sure that aërobic conditions will prevail in the wound.

In order to save as much of the limb as possible it will oftentimes be necessary to disregard the formation of skin-flaps on account of the position of the wound or the area involved in the necrotic process. At other times, a certain amount of skin may be available as a flap covering without sacrificing the length of the limb. In either case, the wound is to remain completely open during the course of the after-treatment, and the skin, if left to itself, will gradually retract and eventually necessitate a second operation to secure a painless and useful stump covering.

In order to prevent, or limit as far as possible, the skin retraction in these wounds, a method was devised which constantly pulled upon the skin during the period of after-treatment. This method proved to be highly successful in quite a number of these cases and is recommended on account of its simplicity and effectiveness. It consists of gluing a wide piece of canton flannel material to the skin, about two inches above the edge of the wound and with the "hairy" side of the material next to the skin. Sewn to this wide piece of canton flannel are four narrower pieces of the same material, two inches apart, and having a short piece of narrow webbing attached to each of the four pieces, as shown in Fig. 11.

This apparatus is not used until three or four days have elapsed after the operation so that nothing may interfere with keeping the wound wide open. Although a certain amount of sloughing takes place in these cases, it quickly clears up under wet antiseptic dressings and, after three or four days, it is safe to apply the apparatus.

It not infrequently happened that previously amputated cases, in which the wound had been left open, were admitted at the American Ambulance. These cases, some of them several weeks old, were also successfully treated with the skin-traction apparatus.

When the wound is to be dressed, the extension straps are laid back and do not interfere with this procedure. Narrow strips of rubber tissue, placed cross-wise, cover the raw surface and over this is placed



FIG. 1.—A fatal case of gas bacillus infection in a perforating bullet wound of the right leg, resulting in a compound comminuted fracture of both bones, showing the characteristic discoloration, slight swelling and typical cluster of blebs. Patient received at hospital six days after injury and an immediate amputation performed at middle third of thigh. There was no injury to the anterior tibial artery.



FIG. 2.—Fatal case of gas bacillus infection of the arm and forearm, following a high explosive shell wound of upper arm. Patient received five days after injury and an immediate amputation performed at shoulder-joint.



FIG. 3.—Showing a gas bacillus infection of a mutilating shoulder wound, due to a high explosive shell fragment, and accompanied by necrotic infiltration of a large part of the chest wall which proved fatal. The patient was received five days after injury and the necrotic material was removed, followed by a continuous irrigation. (By courtesy of the Harvard Unit.)



FIG. 4.—A case of first grade gas bacillus infection, the result of a bullet wound, involving a slight splintering of the iliac crest. Patient was received three days after injury, the onset being less rapidly progressive than the usual ragged shell wounds. Note the slight brownish discoloration in the skin adjacent to the wounds.



FIG. 5.—Showing the method of trench construction and the conditions under which wounds become infected.

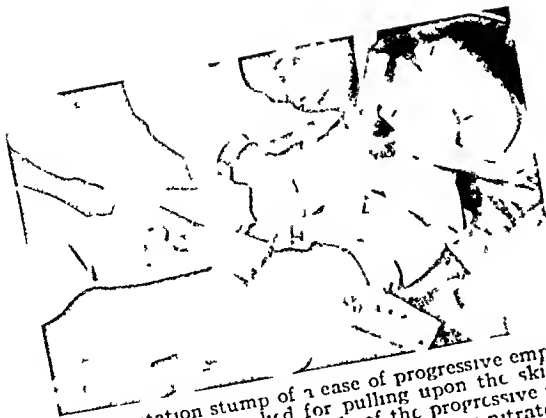


FIG 6—Showing an amputation stump of a case of progressive emphysematous necrosis (gas bacillus infection) with the apparatus applied for pulling upon the skin. This amputation was performed during the latter part of the second grade of the progressive process. The black staining shown upon the skin of the stump was caused by the silver nitrate solution used as a moist dressing.

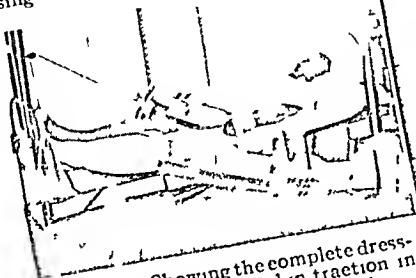


FIG 7—Showing the complete dressing and apparatus for skin traction in position in the same case as Fig 6

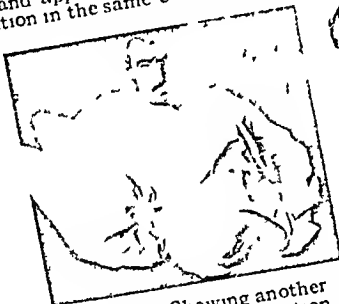


FIG 9—Showing another second grade amputation after two weeks use of the skin traction apparatus. In this case it was permissible to allow a certain amount of skin flap at the time of operation although no sutures were used and the wound was treated openly throughout.



FIG 8—The same as Fig 7, showing the improvement in skin growth over the stump at the end of two weeks.



FIG 10—Showing an old amputation case under treatment with the skin traction apparatus. This case improved steadily and, after one month, a minor plastic operation completed the cure.

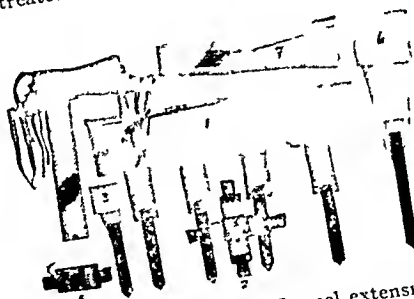


FIG 11—Showing the pattern of the canton flannel extension straps used for the purposes already mentioned. The material used was a medium-weight canton flannel. 1, the broad piece with extension straps, used for the skin traction apparatus; 2, the wooden cross-piece to which the above extension straps are buckled; 3, cloth, with webbing extension, which is glued to the forearm in the overhead extension treatment of compound fractures of the humerus; 4, wooden traction piece to which the foregoing webbing is buckled; 5, cloth anklet used to obtain extension on the foot in cases where the wound in the leg was low down or involved the ankle-joint; the horizontal piece is secured over the dressing around the ankle while the vertical piece turns under the plantar surface and is afterward pinned to the horizontal piece; 6, cloth extension strap used with the Blake splint; 7, a double extension cloth, the ends of which are glued to the leg, used as a substitute for adhesive plaster in the application of a Buck's extension.

GAS BACILLUS INFECTION

the wide gauze pads which are then secured in place by a narrow strip of gauze surrounding the dressings at the end of the stump. The extension straps are now brought over the end of the stump and the webbing is buckled to corresponding webbing on a cross-piece of wood. The latter has attached to it a cord, which passes over a pulley, attached to an upright at the foot of the bed, and secured to a bag containing five to seven pounds of weight. In order to make sure that the dressing will not slip off the wound, two long narrow strips of gauze are secured cross-wise over the dressing and pinned to the wide piece of canton flannel which is glued to the skin, the strips of narrow gauze passing through the intervals between the extension straps. In order to make a better pinning surface for the strips of gauze, it was necessary to apply five or six turns of a wide gauze bandage snugly over the broad piece of canton flannel glued to the skin. This arrangement was kept up usually for about a month, the dressings being renewed daily, and by that time the skin had usually come down over the stump to such an extent as to be able to dispense with the apparatus entirely.

The preparation used to glue the canton flannel to the skin for the traction apparatus, also to glue the extension straps to the leg in the application of the Blake splint, and to glue the extension straps to the forearm in the overhead extension treatment of compound fractures of the humerus, is as follows :

| | |
|-------------------------|----------|
| Resin | |
| Alcohol, of each | 50 parts |
| Benzine | 25 parts |
| Venice turpentine | 5 parts |

NOTE.—Powder resin; add half of the alcohol; add all of the Venice turpentine with the benzine, and then wash the measure with the remainder of the alcohol.

As regards the treatment of the third or septicæmic grade of *progressive emphysematous necrosis*, there is practically nothing that can be done to ward off a fatal result. Rectal salt solution with adrenalin chloride, slowly introduced, will aid other stimulants in prolonging life; while blankets and hot-water bottles will prevent the rapid lowering of body temperature. The serum treatment, and all other measures that have been tried, have signally failed when once the septicæmic grade has begun. The only hope offered is to prevent the onset of the third grade by prompt amputation in the latter part of the second grade and before the patient is too weak to stand the shock of operation.

THE SIGNIFICANCE OF FOREIGN BODIES IN THE TISSUES*

BY WALTON MARTIN, M.D.

OF NEW YORK

SURGEON TO ST. LUKE'S HOSPITAL

My attention has been drawn to this subject by the very different significance of foreign bodies as a complication of gunshot injuries in modern warfare and as seen in civil practice. It has seemed to me of interest to gather together what we know of foreign bodies in the tissues with and without infection. I have used the word tissue to include all parts of the body excepting the cavities lined by mucous membrane and the surfaces covered by epithelium. I have not considered foreign bodies in the œsophagus, stomach, intestines and bladder, that very strange and curious chapter of surgery.

There are two sources of information regarding the behavior of the tissues in the presence of foreign bodies. First, there is a large amount of experimental work, as the subject has always been of interest from the stand-point of general surgery; for not only are large amounts of foreign material introduced as ligatures and suture material, and in plates for holding fractures, but also the attempt has been made to replace tissue defects by foreign substances—for example, the introduction of artificial corneas, plates for skull defects, paraffin for correcting deformities, etc. The subject is also one of great interest to the general pathologist as a means of throwing light on the complex questions of inflammation and new tissue formations.

The second source of information is furnished by clinical reports of cases in which foreign bodies have been accidentally embedded in the tissues.

I shall first review some of the well-known facts about the tissue reaction to foreign materials when no infection is present. Soft and absorbable foreign substances are gradually dissolved and taken up by the tissue cells. Compact and insoluble foreign bodies are shut in by new-formed tissue, which is slowly transformed into a fibrillar connective-tissue capsule, gradually shutting the foreign body off from contiguity with the organism. If the foreign body is hollow or porous, the new tissue grows into it and separates it from the rest of the tissue on the inner as well as the outer surface.

There are no foreign materials in the strict sense absolutely chem-

* Read before the New York Surgical Society, October 13, 1915.

FOREIGN BODIES IN THE TISSUES

ically and physically indifferent to the tissues. The very presence of the foreign body implies an alteration in nutrition and a damage to the tissue caused by the dislodgement of cells to make place for the foreign body.

Very finely divided particles, such as the pigment introduced in tattooing, or other substances in powdered form are partly taken up by the leucocytes and carried away, and partly remain *in situ* and may be recognized in the tissue spaces between the connective-tissue bundles and in the connective-tissue cells. The pigment also finds its way into the lymph-stream and may be found in the neighboring lymphatics. In tattooing the arm, the axillary lymph-glands are found loaded with pigment. When large masses of powder are introduced, however, a process of encapsulation of the entire mass takes place.

The most characteristic cells in the reaction caused by the presence of all but the finest particles of foreign material are the so-called foreign-body giant-cells with many nuclei arranged near the periphery. The cells are of frequent occurrence in the cicatricial tissue following surgical operations, forming in the immediate neighborhood of threads of cotton, minute particles of gauze, insoluble suture material, and after injury in which small particles of foreign material have been introduced. They are interesting because the microscopical findings so closely resemble tuberculous tissue. These cells obviously possess the property of attacking and dissolving foreign substances.

Size, shape, weight, and consistency are apparently of slight significance when the body is at rest, in relation to the surrounding tissue, but motion of the body in the tissue, especially if it be pointed or have an irregular surface, causes a marked reaction. Under these conditions, a capsule containing fluid is formed, the organism apparently reacting to the repeated trauma of contact with rough or pointed bodies, by surrounding them with fluid. Such cysts, produced by the trauma of a foreign body, have frequently been observed experimentally. They contain a pinkish, sterile serum.

The effect of motion in setting up irritation has often been observed clinically. It is especially frequent about small foreign bodies in the fingers. Kummer¹² removed a cyst the size of a pea, formed about a fragment of needle which had been embedded in the finger for three years. The little cyst was pear-shaped; the stem of the pear was formed by part of the needle closely surrounded by tissue. The other end of the needle projected into a small bulbous cavity. The part of the needle closely surrounded by tissue was eroded and thinned; the part that projected into the cyst was of the original size and appearance.

At times, pointed foreign bodies, such as needles, seem to have a tendency to be pushed through the tissues, the pointed end piercing the tissues during certain muscular actions. There are numerous clinical observations and pathological anatomical autopsy findings that prove without doubt this travelling of foreign bodies in the tissues. Some years ago I cut down on a needle in the palm of the hand, shown in that position distinctly by an X-ray photograph the day before. After a long search I was unable to find the needle. It was then shown by a fluoroscopic examination to be beneath the annular ligament, and from this position, about four inches above the point where it was first observed, it was readily removed. Such experiences are not uncommon.

Aside from the movement of pointed foreign bodies, there have been a few reports of embolic transference of projectiles.

Schloffer²⁴ (1903), in a paper on this subject, reported experiments on rabbits in which he had introduced shot into the inferior vena cava. At autopsy, the shot was found in the pulmonary arteries. He also reported four cases, two of his own, and two from the reports of others. Rubesch²⁵ showed in Prague, on March 8, 1912, a patient whose history is very interesting. He was a man twenty-eight years old, who, in an attempt at suicide, shot himself over the heart. The weapon used was a 7 mm. revolver, of old construction and poor quality. The wound of entrance was about 1.5 cm. inside the left mammary line, and 5 cm. above the nipple. There was no wound of exit. He was taken to the hospital and the next morning, after recovering from the preliminary shock, his only complaint was a severe pain in the right leg. The pulse in the right and left femoral was the same. The pulse in the right dorsalis pedis could hardly be felt. The right leg felt cool. X-ray examination showed no projectile in the thorax. Examination of the right leg, however, showed the bullet in the position of the right femoral artery. Two days later, after provisional ligation of the external iliac, the right femoral was exposed and the bullet was felt within the vessel. The vessel wall was incised and the bullet, which was tightly wedged in the lumen, was removed. It lay with its long axis corresponding to the long axis of the vessel, and its base directed centrally. It weighed 2.85 grammes. Centrally and peripherally to the bullet were thrombi. The clots were removed and the vessels were sutured with paraffin silk. The operation was followed by gangrene of the leg, making necessary an amputation through the lower part of the thigh.

A critical examination of this and the other reported cases seems to prove beyond question the possibility of the transference in the bloodstream of small projectiles of low initial velocity, the bullet passing in a very short time from its point of entrance, over the heart or one of the great blood-vessels, to be lodged, like an embolus, in one of the arteries.

The capsules found about foreign bodies vary according to their chemical characteristics. Bodies not chemically active seem to find

FOREIGN BODIES IN THE TISSUES

lodgement in the tissue with astonishingly little reaction. The capsule is very simple and is made up of fibrillar connective tissue. The tissue cells lie in close contact with the foreign body. Bodies like celluloid, glass, hard rubber, quartz, etc., readily heal in the tissue provided they are not movable in relation to the surrounding tissue. Salzer, in one instance, succeeded in embedding an artificial cornea which remained *in situ* for two and a half years. Von Eiselsberg¹⁸ reported a case in which he had replaced a defect of the sternum, following resection for tuberculosis, with a celluloid plate. The plate was covered by a skin-flap. After four and a half years, this foreign body was still firmly in place in the tissue, and the skin was freely movable over it.

In bodies of greater chemical activity, more irritation is caused in the tissues. The capsule is not so simple; about copper, for example, there are three layers recognizable. First, in immediate contact with the foreign body is a layer made up of cell detritus and dead material, then a layer of spongy connective tissue, and, finally, a layer—the one farthest from the foreign body and in immediate contact with the rest of the organism—made up of fibrillar connective tissue. The capsule about iron is loaded with pigment cells, having staining properties which suggest their identity with ferratin. The appearance is analogous to that seen in the absorption of inorganic iron from the intestinal tract (Bayer).² The capsule about silver is very simple and the silver seems little acted upon by the tissue cells. Aluminum seems to occupy an intermediate position between silver and copper. The five metals, silver, aluminum, brass, iron and copper, can be arranged in this order according to the irritation they create in the tissues. The capsule in many instances is lined by a layer of cells which suggest epithelium. By suitable stains, however, the cells can be demonstrated to be modified connective-tissue cells.

Years ago, Nussbaum²¹ (1853), in his studies on artificial corneas, introduced small spheres of glass, iron, wood and copper under the skin in his own body, and noted the difference in the amount of irritation produced. Glass provoked almost no reaction, copper, on the other hand, caused so much that he was compelled to remove the stitches on the second day.

The different tissues seem to react very differently to the same foreign body. Leber (1891) made an interesting observation in this connection. He found that copper would heal in the crystalline lens almost without reaction, yet caused severe pathological changes when introduced into the vitreous or anterior chamber. Shortly afterward, Wagenmann²⁷ reported a case which offered clinical confirmation of

this point. By the explosion of a percussion cap, a small fragment became embedded in the crystalline lens of a boy ten years old. Twenty-seven years later Wagenmann removed the lens for cataract and found a small fragment of copper embedded in it. Until two years before the operation the lens had been clear and the eyesight, excepting at one point, good. The eye had been repeatedly examined.

Barth⁴ observed strands of catgut unabsorbed, although thinned and eroded, in parenchyma of the kidney after seven months, but found them completely absorbed in the fibrous capsule.

In the muscular and connective tissues there are many examples of foreign bodies which have remained without reaction for years. In the heart muscle bullets and other foreign bodies have frequently been reported. Within the last five years, Bailey,³ Chandler,⁵ Kunreuther,²⁵ Leporski,²⁵ Magnagnon,²⁵ Northrup,²² Sternberg,²⁵ Zesas²⁵ have all reported cases. I give in full the autopsy findings taken from the case of Huppert¹⁰ (1876). He found at autopsy a needle embedded in the posterior part of the left ventricular wall. The end projected into the ventricular cavity. The pointed end was covered over by a dull yellowish-white tissue, smooth like the rest of the endocardium, and under the microscope it appeared lined by elongated four-sided flat cells. The underlying portion was made up of fibrillar connective tissue. From the history, the needle had been in the tissues for five years. The heart valves and the heart muscle were normal. During life there had been no signs of cardiac irregularity.

The part of heart wall occupied by the foreign body is of importance. In certain situations, the irritation caused by it, according to the well-known experience of physiology, produces irregularity in the heart beats, pain, etc. The chief danger seems to be at the time of entrance of the foreign body. Marked disturbances may also be caused by its extraction.

In the brain there are also a great number of observations of embedded bullets. I have shown this evening a man, fifty-five years old, who was shot in the head thirty years ago. The X-ray plate shows the bullet in his brain. Dr. LeWald has kindly also shown the plate of a second case in which the bullet has remained in the brain for fifteen years. A copy of this plate is in Lagard's¹⁷ book on gunshot injuries.

In bone, bullets and other foreign substances heal readily. There is usually a connective-tissue capsule immediately about the foreign body, and then a layer, more or less marked, of sclerotic bone. In some instances there is no connective-tissue capsule, the foreign body lying in immediate contact with bony tissue. In avascular cartilage there is

FOREIGN BODIES IN THE TISSUES

no capsule, the foreign material often lying almost reactionless in its bed.

There is a curious observation by Bayer² regarding the behavior of copper in joints. He oxidized copper wire and introduced it into the knee-joint, and into muscle, tendons and periosteum. After two days, all the pieces of copper were examined. All except those in the knee-joint had the dark color of copper oxide. The pieces in the joint had lost their dark color and had the shiny appearance of metallic copper. He attributes this to the reducing action of the synovia. There is no statement as to whether or not the joint was kept at rest.

There have been many observations on these chemical changes that occur after bodies have been lodged in the tissues. I think every one who has removed a needle which has been for some time in the tissues has been impressed by its coal-black appearance, often shown in sharp contrast to the tissues, especially if they have been made bloodless by the application of an Esmarch bandage. Iron, lead, and copper all undergo chemical alterations when in contact with body fluids,—by oxidation and the formation of metallic salts, especially carbonates and chlorides (Marchand).¹⁸

Lewin (1911)¹⁰ has advanced the view that lead, which has remained for years undissolved in the tissue, may undergo chemical change into soluble lead salts, be absorbed, and produce toxæmia. He points out that the surface of a projectile is relatively small, and that greater opportunity for chemical action would be offered if the bullet were broken up or if small shot were introduced. That the clinical signs of lead poisoning are so rarely seen he attributes to the fact that the symptoms of lead intoxication are so easily overlooked or falsely interpreted. But that the bullet can set up severe toxic manifestation he offers several interesting observations.

In 1892 Lewin had reported a case with Kuster which brought the matter to his attention. A soldier had been wounded at the battle of Mars la Tour, August 16, 1870. The wound of entrance was over the head of the tibia; there was no wound of exit. He was discharged cured in October. The bullet was not extracted during his treatment. He remained well until 1888, except for occasional joint pains. He then began to present the symptoms of lead poisoning, anæmia, weakness, colic, lead line on the gums and trembling of the hand. At operation there were scattered areas of blue-black stains in the head of the tibia, and the neighboring connective tissue and knee-joint. These areas were removed and the patient recovered from the symptoms of lead poisoning. The chemical examination by Lewin of the fragments showed the presence of lead oxide, hydroxide and carbonate.

It was apparently a case of fragmentation of a lead bullet, with chemical change of the fragments of the metal into soluble leads with absorption and poisoning.

It would seem from the very common occurrence of lead bullets in the tissues and the extraordinary rarity of the symptoms of lead intoxication that Lewin's views should be accepted with caution. He has collected the reports of seven cases since 1892.

There is abundant evidence, then, that bullets, needles, in fact all manner of foreign bodies, can remain for years in the tissues, encapsulated, shut off from the organism and causing no irritations, or, in very rare instances, perhaps giving evidence by a general toxæmia of their slow dissolution; but all these facts are based on the supposition that no pathogenic micro-organisms have been introduced at the same time, or, if they have been introduced, that they have been either destroyed or made innocuous by the body cells. The behavior of the tissue in the presence of infected foreign bodies is very different. One of the oldest surgical principles, as well known as the relief offered by the opening of an abscess, is that a suppurating sinus leading to a foreign body will close if the foreign body is removed. So wide-spread is this knowledge that to the layman to this day the extraction of bullets is the *sine qua non* in the treatment of gunshot wounds.

A study of the reaction of the tissues to infected foreign bodies is of great interest.

If a small number of organisms of low virulence are introduced with the foreign body, it is possible for the embedded foreign body to heal in the tissues, the organisms being destroyed by the bactericidal properties of the tissue. It is also well known that bacteria can be shut up in the tissue and rendered harmless and yet years afterward through some lowering of tissue resistance take on pathogenic properties.

Two years ago I operated on a circumscribed bone abscess of the tibia. It was surrounded on all sides by dense sclerotic bone. The pus from the abscess contained a pure culture of typhoid bacilli. The man had had typhoid fever forty years before. The micro-organisms had apparently been living in his tissues for years, shut in, encapsulated, innocuous. Through some accident, possibly trauma, the balance between living tissue cells and living micro-organisms was upset and the latter took on pathogenic activity. In the same way there are numerous instances of foreign bodies remaining for years in the tissues without reaction, and then causing signs of local inflammation.

Years after all the great wars, there have been instances of this character. A soldier ran a piece of glass the size of a small coin into the sole of his foot. It remained there twelve years. He could stand and march without feeling pain. At the end of this time suppuration was set up around the foreign body (Weitz).⁶ It is not difficult to

FOREIGN BODIES IN THE TISSUES

imagine that lowered tissue resistance, or injury of the connective-tissue capsule may afford an opportunity for the imprisoned dormant micro-organisms to start growing. Possibly the tissues about the foreign body may be a point of least resistance suitable for the lodgement and growth of pathogenic bacteria which have entered the body. Harland (1878)¹¹ removed a projectile from the palm of the hand. The bullet had been there fifty-nine years. The patient was eighty-three years old; he had been wounded at Waterloo, and had done heavy work as a gardener and laborer. A similar experience is not uncommon in bodies embedded as a deliberate surgical procedure. Foreign substances, introduced to correct deformities or to fill defects, heal in the tissue, often with evidence of considerable tissue reaction, and then after a period of weeks, months, or even years, show the signs of local suppuration, necessitating incision and subsequent removal of the foreign body to close the sinus which inevitably follows.

Aside from organisms introduced in small quantities or of low virulence giving rise to what may be termed resting or latent infections, there is the vastly more important question of the introduction of foreign material and micro-organisms in sufficient numbers and of sufficient virulence to set up infections, and the question of the unfavorable influence exerted by these foreign bodies on the progress of the infection.

Since Pasteur's²⁶ communication in 1878 in which he told how sheep allowed to graze in a meadow sprinkled with a virulent anthrax culture rarely died of the disease, yet perished in numbers when prickly plants which could wound the mouth, pharynx and tongue were added to the fodder, the relations between solution of surface continuity; injury and infection have been well recognized. There is no sounder surgical principle than that mechanical violence predisposes to infection. The introduction of a foreign body is a form of traumatism, there must always be damage to the tissue by death and dislodgement of cells to make place for the foreign body. Finely divided foreign bodies, introduced experimentally into the peritoneum or pleura, aid to a very marked degree the activity of the micro-organism inserted at the same time. Each foreign particle forms a focus favorable to the growth of micro-organisms. They appear to make it difficult for the protective forces of the tissue to act. The normal outcome, if the bacteria do not overwhelm the organism, seems to be toward the extrusion of the foreign body.

The majority of gunshot injuries in the present war are complicated by infected foreign bodies. Fragments of shell casing and irregular

shrapnel balls carry with them into the contused and lacerated tissue, surface dirt, hair, clothing and all manner of small foreign bodies. The rifle bullet of high initial velocity carries with it, in wounds of parts of the body covered with clothing, threads and fragments along the bullet tract and forces them into the tissues. The dangerous nature of particles of clothing was long ago pointed out.

Fischer⁹ (1882) writes, "When one thinks of the shocking condition of the clothing of soldiers in the field, one can easily imagine the danger of carrying fragments into the wound." Particles of clothing found with the bullet are of common occurrence in gunshot wounds occurring in civil practice. Eight years ago¹⁰ I reported before this Society a case of gunshot wound of the stomach. The bullet passed through the abdominal wall, the anterior and posterior wall of the stomach, the diaphragm, pleura, and lodged in the muscles of the back. The stomach wounds were closed and the pleura drained a few hours after the injury. Three weeks later I removed from the back the bullet and pieces of clothing which were lying in a small abscess containing 2 drachms of pus. The injury was inflicted with a 32 calibre revolver. But the significance of the clothing is not the same in such cases.

Fontin and Karlinski¹⁴ found virulent staphylococci, streptococci, *B. coli communis* on fragments of old, well-worn uniforms. Experiments done with the German mantled bullet with high initial velocity have shown that particles of clothing are carried into the bullet tract, and that some of these particles are even forced into the healthy surrounding tissue. The old-time projectile of lower initial velocity has no such effect. It has also been shown experimentally that it is impossible to disinfect these bullet tracts either with chemicals or the thermocautery.²⁰

Koller,¹⁵ seventeen years ago, concluded an article on experiments on the Treatment of Infected Gunshot Wounds, with the statement that he agreed with Bruns in strongly combating the idea that every gunshot wound must be treated as an aseptic wound and covered with an occlusive dressing. The majority of gunshot wounds, on the contrary, did not belong to this category. It was only true of the lighter grades of bullet injuries.

Particles of dirt, threads of clothing and other small foreign bodies also adhere to the rough surface of fragments of shell casing, to detached bullet mantles, to pieces of shrapnel, so that the question so often discussed as to how often the bullet itself is a source of infection hardly comes under discussion. Not only are foreign bodies particles infected but they are carried, each with its modicum of infection, into lacerated, contused and detached tissues. Projectiles striking bone

FOREIGN BODIES IN THE TISSUES

communicate to the shattered fragments their own force, and each particle, itself a minute projectile, is hurled through the tissues. Even when the projectile has passed out of the body it is often astonishing to see the number of fragments of clothing, etc., that can be removed from even a superficial seton wound by drawing through the wound tract a piece of knotted sterilized gauze. It would be difficult to arrange experimentally better conditions for infection, especially when one considers the imperfect immobilization after the injury is received and the lowering of general body resistance from pain, hemorrhage, loss of sleep, exposure, all inevitable before the patient can reach a base hospital.

Besides the pyogenic organisms, many others, ordinarily saprophytic, are carried with them on foreign bodies into the tissues and often take on pathogenic properties. These are the conditions which have been a chief factor in giving rise to the dictum now going about among the surgeons in Europe—"War surgery is not peace surgery." These are the conditions which account for that curious, heavy, sickening odor caused by great numbers of suppurating wounds, which one notices in all the large war hospitals. Large incisions properly placed for drainage, removal of detritus, detached fragments of bone and tissue and all accessible foreign bodies, flushing of wounds with peroxide as means of cleansing mechanically, the bubbling of the solution loosening up minute fragments of foreign material and enabling them to be washed away, has become the routine treatment for the severe wounds.

I have wished to draw this sharp contrast between what we know of foreign bodies introduced into the tissue with the least possible trauma, and with as little infection as possible, and the foreign bodies introduced with enormous trauma and often with much infection. The foreign body has a very different significance when introduced through comparatively clean skin and clothing, with low initial velocity, and receiving immediate care, and introduced as we have described and seen it under the condition of modern warfare.

The significance of a resting uninfected foreign body imbedded in the tissue is simply mechanical; it may demand removal from pressure on a nerve or from interference with function.

The significance of an infected foreign body is twofold; it is a focus of infection, from the micro-organisms carried with it into the tissues, and at the same time it exerts an unfavorable influence on the protective forces of the tissues. Its removal takes away a source of infection and is one of the means of aiding the body cells to resist the growth and spread of pathogenic bacteria.

BIBLIOGRAPHY

- ¹ Aschoff, L.: Pathologische Anatomie, vol. i, p. 610.
- ² Bayer, H.: Einheilung von Fremdkörpern (full bibliography). B. Z. Kl. Chir., 58, 1908; Münchener Medizinische Wochenschrift, 1909, p. 2416.
- ³ Bailey, C. H.: A Case of Foreign Body in the Heart. Arch. of Internal Medicine, vol. xi, 1913.
- ⁴ Barth: Nierenbefund nach Nephrectomie. Arch. f. klin. Chir., vol. lxxiv, sec. 2, 1893.
- ⁵ Chandler: Heart in Which a Needle Was Found Embedded in the Intraventricular Septum. British Medical Journal, April 22, 1911.
- ⁶ Doran, A.: On Certain Foreign Bodies Embedded in the Tissues Without Producing Inflammatory Symptoms. St. Bartholomew's Hospital Rep., xii, London, 1876.
- Fraenkel: Foreign Body in Heart. Münchener Medizinische Wochenschrift, 1914, p. 1201.
- ⁷ Fischer: Handbuch der Kriegschirurgie, 1882.
- ⁸ Gussenbauer: Die Traumatischen Verletzungen. Deutsche Chirurgie, Lief. 15, 1880, Chap. III.
- ⁹ Huppert, M.: Eine Nähnadel im Lebenden Herzen. Arch. der Heilkunde, 19 Jahrg., 1878, p. 517.
- ¹⁰ Harland: British Medical Journal, 1878, p. 788.
- ¹¹ Kummer: Kyste développée autour d'une aiguille. Revue de Chir., 1891, N. 7.
- ¹² Kirschner: Paraffin Injectionen in Menschlichen Gewebe. Virch. Arch., Bd. 182, H. 3, 1905.
- ¹³ Karliński: Centralb. f. Bakt., 1 Abt., vol. xviii, 1895.
- ¹⁴ Koller, F.: Experimentelle Versuche über die Therapie inficirter Schlusswunden (full bibliography). Deutsch. Zeitschrift für Chirurgie, vol. xlvii, 1897-1898, p. 211.
- ¹⁵ Lewin, L.: Das toxische Verhalten von Metallischen Blei und besonders von Bleigeschossen in tierischen Körpern. Vol. xciv, 1911.
- ¹⁶ Lagard: Gunshot Injuries. New York Medical Journal, October 22, 1892, p. 164.
- ¹⁷ Marchand, F.: Der Process der Wundheilung, Deutsche Chirurgie, Lief. 16, 1901, Chap. xxvi, p. 353. Die Einheilung der Fremdkörper (full bibliography).
- ¹⁸ Martin, W.: Lesions Associated with Gunshot Wounds of the Stomach. ANNALS OF SURGERY, vol. xlv, 1907, p. 699.
- ¹⁹ Müller, A.: Experimentelle Untersuchungen über die Infection von Kaninchen durch Geschosse. Deutsche Zeitschr. f. Chir., vol. xlvii, p. 199.
- ²⁰ Nussbaum, J. N.: Deutsche Klinik, No. 34, August 20, 1853.
- ²¹ Northrup, W. P.: Needle in Left Ventricle of Heart. Pediatrics, vol. xxv, No. 7, 1913.
- ²² Rubesch, R.: Ein Beitrag zur Embolischen Verschleppung von Projectilen. B. Z. kl. Chir., vol. lxxx, 1912.
- ²³ Schloffer, H.: Neben Embolische Verschleppung von Projectilen. B. Z. kl. Chir., vol. xxxvii, February, 1903, p. 698.
- ²⁴ Thorel, Ch.: Pathologie der Kreislauforgane des Menschen (bibliography). Ergebn. der Allgemeinen Pathologie, vol. xvii, 1915, p. 692.
- ²⁵ Vallery-Radot: La Vie de Pasteur, p. 407.
- ²⁶ Wagenmann: Beitrag zur Kenntnis der Zündhütchenverletzungen des Auges. Arch. f. Ophth., 44, 1897.

PRIMARY NEOPLASMS OF THE LYMPHATIC GLANDS INCLUDING HODGKIN'S DISEASE*

BY WILLIAM B. COLEY, M.D.
OF NEW YORK

THIS paper is an attempt to add some further clinical data bearing upon primary tumors of the lymphatic glands, on the basis of a study of 167 cases personally observed.

I scarcely need state that this group of neoplasms gives the most hopeless prognosis of any in the entire field of malignant tumors—hopeless not only from the stand-point of surgery, but also as regards X-ray and radium treatment.

I should like to discuss the clinical diagnosis of neoplasms of the lymphatic glands if time and space permitted. I can merely say that while in many cases it is possible to make a correct diagnosis from clinical signs alone, together with the history of the case, rapidity of growth, and blood examinations, in most cases a positive early diagnosis cannot be made without a microscopic examination, and not always then. I do not believe there is much risk in an exploratory operation for the removal of enough tissue for a microscopic examination. In many of these cases the tumor is made up of a considerable number of more or less discrete glands, and one small gland can be taken out with little risk of producing generalization of the disease.

The almost hopeless prognosis of the disease has been emphasized by the paper of Fabian¹ based upon the results of treatment in a large series of cases collected by him. "Operation," he emphatically declares, "can come into consideration only in such cases in which the site of the disease is isolated, a thing which it is often difficult to prove. It is furthermore necessary to exclude leukæmia and pseudoleukæmia by quantitative and qualitative blood analysis, tuberculosis by Pirquet's and lues by a Wassermann reaction." He further holds that, in view of the extreme difficulty in making an early definite diagnosis, it is essential to do an exploratory incision for the purpose of microscopic examination which in the majority of cases enables one to differentiate between lymphosarcoma and Hodgkin's disease. "Clinically," he states, "these two conditions may be deceptively similar, a circumstance which would not be of great importance were the treatment of the two lesions the same. This, however, is not the case. Operation,

* Read in abstract before the American Surgical Association, June, 1913.

¹ Münchener med. Wochenschr., August 26, 1913, No. 34, 1876.

according to our present knowledge, is contra-indicated in cases of malignant lymphoma even if localized in character, numerous observations having shown that in these cases, as in leukæmia and pseudo-leukæmia, the most thorough excision often does not check the progress of the disease, but, on the contrary, causes more rapid proliferation."

"On the basis of the collected experience up to the present time," Fabian states, "we must admit that surgical treatment in general has been most discouraging." He cites the exhaustive compilation of Dufhus, in 1895, comprising 22 cases of lymphosarcoma of the neck and axilla observed at the Grcifswald Clinic. Of these 3 were inoperable; 3 of the remaining 19 were operated upon by exploratory incision only; 6 of the cases treated by radical operation had a speedy recurrence; 9 left the clinic well but in 4 of these a recurrence was soon observed; 1 patient was operated upon four times. No permanent cures are mentioned.

The number of cases in which the appearance of the sarcoma in the cervical glands is preceded by an attack of tonsillitis or sore throat, points very strongly to an infectious origin. One of the cases in my series, which I have given in some detail, also points very strongly toward an extrinsic and infectious origin other than through the tonsil. In this case the patient cut her finger on a vase; a swelling in the axillary gland on the same side almost immediately appeared and developed into a rapidly growing sarcoma. Of course, in this case it is not possible to prove the causative connection between the prick of the finger and the sarcoma; the latter may have been merely a coincidence, still, in connection with the cervical cases following an infection in the tonsil, it is certainly suggestive.

There is much evidence pointing to a very close relationship between the groups of tumors at present designated as malignant tumors—sarcoma and carcinoma—and the group regarded as Hodgkin's disease. Indirect evidence of this close relationship is suggested by the recently published experimental work of Dr. Maud Slye, of Chicago, covering a period of ten years. She found that cancer was apparently hereditary in mice, and was able to produce a breed of mice in which practically every member of the family died of cancer. Aside from the question of heredity, which is irrelevant to the topic under discussion, she found that all the different types of malignant disease were produced in these cancer families, one having carcinoma, another sarcoma, another epithelioma, and still others, Hodgkin's disease and lymphatic leukæmia. Furthermore, these latter conditions she has never observed except in cancer families.

To turn for the moment to the histological features in these different

PRIMARY NEOPLASMS OF LYMPHATIC GLANDS

tumors of the lymphatic glands, we find there is great difference of opinion in characterizing the histological structures.

In one of my cases, a tumor of the axillary glands was pronounced, in the original report, lymphosarcoma, and the same pathologist two years later described it as an endothelioma. Other specimens were pronounced round-celled sarcoma by one pathologist and Hodgkin's disease by another. This is a common observation. Not infrequently have I received the following opinion:

"The tumor is certainly malignant, but whether sarcoma or carcinoma, I am uncertain." The term "embryonal carcinoma," much used of late, is being more and more frequently employed to describe some of these border-line cases. Herein lies the great significance of the study of primary neoplasms of the lymphatic glands. This study leads one to pay less and less heed to the finer histological distinctions, the "judicial niceties" of the microscopic examination in these cases—the interpretation of which is by no means clear—but rather to group the cases according to certain well-defined clinical features. Thus we have a group of the so-called Hodgkin's type of tumors, or neoplasms of the lymphatic glands, with fairly distinct clinical features, sufficiently characteristic in the ordinary case to make the diagnosis comparatively easy, namely:

1. Enlarged glands, usually beginning (in the cervical region) on the one side, and soon involving those on the other side; freely movable; more or less discrete, skin not attached; moderately firm in consistence but not fluctuating, gradually followed by involvement of the axillary and inguinal glands, and not infrequently the spleen and liver; a blood picture which Bunting and Yates believe to be peculiarly characteristic; a more or less rapid deterioration in general health, uniformly ending in death.

2. The ordinary type of round-celled sarcoma of the cervical glands, beginning as a single nodule, softer in consistence and more apt to infiltrate the surrounding tissue than in the Hodgkin's type; may extend to the glands on the opposite side, but this is not usual in the early stages; more rapid increase in size, and more frequently associated with pain; running a much more rapid course than the ordinary Hodgkin's and only infrequently causing general metastasis. It resembles Hodgkin's in the fatal prognosis. The differential diagnosis of this type of tumor from tuberculosis is not usually difficult, owing to its very rapid progress without any tendency to become caseous.

Then we have a third group of cases designated ordinarily as lymphatic leukæmia, which differs from the Hodgkin's very little except in the blood picture. I believe it is possible to regard this group of cases

as closely allied to Hodgkin's, and perhaps as a different stage of the same disease. A uniformly hopeless prognosis is common to each of these different groups.

THE TREATMENT OF PRIMARY SARCOMA OF THE LYMPHATIC GLANDS

If the disease is discovered before more than a single gland has become involved, it should be removed by surgical operation and the patient put upon a prolonged course of treatment with the mixed toxins of erysipelas and *Bacillus prodigiosus* in the hope of preventing a recurrence.

If the disease is primary in the tonsil, and is discovered before the surrounding tissues have become markedly infiltrated, and before metastases have taken place in the glands of the neck, the tonsil should be removed, and if the diagnosis is confirmed by microscopic examination, similar prophylactic toxin treatment should be instituted.

One of the most remarkable cases of an apparent cure is that in which a large tumor, a round-celled sarcoma, of the tonsil and cervical glands disappeared under seven weeks' treatment with the mixed toxins of erysipelas and *Bacillus prodigiosus*, and the patient remained well for nearly seven years, when a similar trouble developed in the opposite tonsil and neck, and rapidly recurred after two operations. Following the recurrence after the second operation the mixed toxins were used for a short time with apparently little effect. The patient died two months later. Here it is fair to believe that the original tumor was completely cured and that the one in the opposite side was an entirely new development, not a recurrence of the original tumor.

In many cases it is almost certain that operation, particularly incomplete operation, greatly increases the malignancy of the tumor and causes it to grow more rapidly than before. Hence, I believe that "palliative operations," or partial operations, in this class of cases are contra-indicated.

In view of the importance of establishing, beyond question, the correctness of the diagnosis, I believe that a portion of tissue, preferably a small isolated gland, sufficiently large to permit of microscopic examination, should be removed; this can be done in most cases without any material risk in the way of causing metastasis or increasing the malignancy of the growth.

The prognosis after X-ray treatment in these cases is not infrequently good as regards immediate result; but, as Fabian states, and my own experience confirms, there have been no permanent cures from the X-rays in this group of cases. The same is true of radium.

PRIMARY NEOPLASMS OF LYMPHATIC GLANDS

HODGKIN'S DISEASE

Assuming the correctness of the view which I have long held that Hodgkin's disease is a type of sarcoma closely related etiologically, I believe the same treatment should be applied to Hodgkin's disease as to sarcoma of the lymphatic glands.

If the disease is discovered in the early stages, when only one or a few glands are involved, most extensive and radical removal, if possible, should be employed, always accompanied by enucleation of the tonsils, if enlarged, as they are the most probable source of primary infection.

Inasmuch as operation alone is practically always followed by a recurrence of the disease, any hope of a cure must depend upon post-operative treatment.

Yates and Bunting believe that long-continued X-ray treatment together with enucleation of the tonsil has apparently effected a cure in two cases, the patients having remained well upward of five years.

It should be noted that in both of these cases the disease was attacked while in the very early stages, both having been sons of physicians, and the disease was recognized comparatively early.

In one case, first treated in November, 1908, diagnosis confirmed by microscopic diagnosis, tonsillectomy was followed by X-ray treatment and hygienic measures. In this case there were only a few enlarged bilateral cervical and axillary glands, with no involvement of abdominal glands, spleen, or liver. In December, 1912, a few glands, smaller than peas, could be felt in the posterior triangle of the neck, but none in the groin. In January, 1914, six years after the beginning of the treatment, the patient was in excellent health; the blood picture was negative.

In the other case of Yates and Bunting, ten years of age, there was slight enlargement of the glands in the axillæ and groins; abdomen negative; blood picture positive Hodgkin's; axillary gland removed for diagnosis; pronounced Hodgkin's. In this case the disease was first noticed in December, 1909; in 1910, tonsillectomy, followed by X-ray and hygienic treatment. September, 1913: glandular condition about the same; a few slightly enlarged glands palpable. January 6, 1914: blood picture normal; glands quiescent. This patient was well at the last observation, made four years after the beginning of the treatment.

Nearly everyone has observed very marked beneficial effects following the use of the X-rays in Hodgkin's disease in almost all its stages; but aside from the cases observed by Bunting and Yates, I believe there is not a single case on record of a cure by this agent; nor do I consider it proper to regard the two cases cited in their series as positive cures.

It should be noted that in both of these cases they were dealing with an early stage of the disease, and there was no evidence of involvement of the spleen or liver, such as was present in my cases treated with the toxins.

My reasons for advocating the toxins in Hodgkin's disease are based upon the remarkable effects that I have observed in a number of such cases, particularly two in which entire disappearance of the lesions occurred.

The following two cases of Hodgkin's disease have been reported somewhat fully in my earlier papers:

CASE I.²—*Hodgkin's disease; clinical diagnosis confirmed by microscopic examination; entire disappearance of lymphatic and splenic enlargement under two months' treatment with mixed toxins of erysipelas and Bacillus prodigiosus, without other treatment.*

G. K., aged twenty-four years; family history negative. This patient felt so entirely well that he refused any further treatment and left the hospital. He gained forty pounds in weight and remained in good condition for about seven months. Shortly after, all of his former symptoms returned, and the disease progressed rapidly, causing death in about six months. This proves the correctness of the diagnosis.

The second case,³ I believe to be so remarkable that I have decided to reproduce it in full.

CASE II.—*Advanced Hodgkin's disease successfully treated with the mixed toxins of erysipelas and Bacillus prodigiosus.*

The patient was treated, under my direction, by Dr. C. E. Preston, of Ottawa, Canada, one of my former house surgeons.

G. M., male, aged nineteen years, was admitted to the Ottawa Hospital May 4, 1908, with a history of glandular swelling beginning on one side of the neck and later involving both sides, of about one year's duration. There was gradual loss of weight and increasing anæmia. The glands of the neck were greatly enlarged; the spleen was enlarged and palpable three-fourths of an inch below the margin of the ribs; the liver extended three inches below the border of the ribs; inguinal glands were moderately enlarged. Weight, 122 pounds. The diagnosis of Hodg-

² Further Evidence in Support of the Theory that Hodgkin's Disease is a Type of Sarcoma. Transactions of the American Surg. Ass'n, 1908.

³ A Report of Recent Cases of Inoperable Sarcoma Treated with Mixed Toxins of Erysipelas and Bacillus Prodigiosus. Cancer Research Society, Buffalo, April 12, 1912, and Surgery, Gynecology and Obstetrics, August, 1911.

PRIMARY NEOPLASMS OF LYMPHATIC GLANDS

kin's disease was made by all of the attending physicians and surgeons of the hospital, and a hopeless prognosis was given.

The mixed toxins were begun June 1, the initial dose being one-fourth minim. This was gradually increased until July 10, when the maximum dose of twelve minims was reached. This caused a temperature of 103° and a rather severe chill. The treatment was continued for three months, partly by the family physician. Examination on January 1, 1909, showed the patient quite well, weight 145 pounds, with only a small gland in the right side of the neck. He had returned to his usual work. The toxins were discontinued.

Reëxamination on September 10, 1909, by the family physician, shows the patient in fine condition, all the glands have disappeared and he continues his hard work. Under date of April 6, 1911, Dr. Preston stated that he had just examined the patient and found him in perfect condition.

Under date of September 1, 1915, Dr. R. E. Webster, of the County Carleton General Hospital (Ottawa, Canada), writes that the patient at present is in perfect health (7 years later). Glandular system is apparently normal. He further adds that, while no glands were removed, the case was a typical one of Hodgkin's disease; all the glandular symptoms were present. The patient was treated from June 1 to July 30, 1908, at the Ottawa Hospital, after which the toxin treatment was carried on by the family physician at home.

In spite of the absence of a microscopic examination there can be little doubt that the diagnosis of Hodgkin's disease was correct.

All evidence of the disease disappeared under no other treatment than the toxins, and the patient has remained well for more than seven years after treatment. I believe this case comes nearer to being a permanent cure than any case thus far recorded.

The more important cases of my series are given in considerable detail in the Transactions of the American Surgical Association for 1915, to which the reader who may be specially interested in the subject is referred, the entire number being reported in tabular form at the end of this paper. Some of the cases have been previously reported in the *Transactions of the Third International Cancer Research Conference* (Brussels, 1913), but inasmuch as this volume can be found probably only in the larger libraries, and in order to make the paper complete, I have thought it wise to reproduce the histories of these cases either in full or in abstract, the most important feature being the addition of full data as to the subsequent progress in the cases that are still living.

The tables cover 167 cases of primary neoplasms of the lymphatic

glands, including Hodgkin's disease, personally observed within the last twenty years:

With regard to locality, the cases are distributed as follows:

76 cases of sarcoma of the neck.

24 cases of sarcoma of the tonsil and neck.

10 cases of sarcoma of the retroperitoneal and mesenteric glands.

17 cases of sarcoma of the inguinal glands.

18 neoplasms of the axillary glands (16 sarcomas, 2 carcinomas).

21 cases of Hodgkin's disease.

1 case of sarcoma of the mediastinal glands.

As regards the relative frequency of lymphosarcoma in the sexes, my tables show a great preponderance of males over females throughout the entire series, except in the mesenteric gland cases, in which the proportion is equal, *e.g.*:

Retroperitoneal and mesenteric glands, 10 cases (5 males and 5 females).

Axillary glands, 18 cases (10 males and 8 females).

Inguinal glands, 17 cases (12 males and 5 females).

Neck, 76 cases (54 males and 23 females).

Hodgkin's disease, 21 cases (16 males and 5 females).

Tonsil and neck, 24 cases (20 males and 4 females).

The duration of life in the fatal cases, so far as definite data are available, may be of some interest:

2 died within ten days.

12 died within a few weeks.

20 died within less than six months.

13 died within six months to one year.

11 died within one to two years.

5 died over two years after the onset of the disease.

A summary of the cases personally observed shows that 26 of the patients have been successfully treated—that is, the tumors (inoperable) entirely disappeared—with the mixed toxins of erysipelas and *Bacillus prodigiosus*, and have remained well from one to twenty-two years. Nineteen patients remained well from three to twenty-two years.

Of 76 cases of sarcoma of neck, 8 have remained well from two to fourteen years.

1 round-celled sarcoma of neck, well two years.

1 sarcoma of neck, well two years.

1 adenocarcinoma of neck, well three years, and then recurred (the primary tumor was pronounced sarcoma).

1 round-celled sarcoma of neck, well four years.

1 round-celled sarcoma of neck, well six years.

PRIMARY NEOPLASMS OF LYMPHATIC GLANDS

1 round-celled sarcoma of neck, well six and one-half years.

1 small round-celled sarcoma of neck, well thirteen years.

1 round-celled sarcoma of neck, well fourteen years.

Of 24 cases of sarcoma of tonsil and neck, five have remained well from one and one-half to nine and one-half years.

1 round-celled sarcoma, well one and one-half years.

1 round-celled sarcoma, well four and one-half years.

1 round-celled sarcoma, well six years.

1 spindle-celled sarcoma, well eight years.

1 round-celled sarcoma, well nine and one-half years.

Of 10 cases of sarcoma of the mesenteric and retroperitoneal glands, 4 have remained well from one to twelve years.

1 round-celled sarcoma, well one year.

1 round-celled sarcoma, well two years.

1 spindle-celled sarcoma, well two years.

1 spindle-celled sarcoma, well twelve years.

Of 17 cases of sarcoma of inguinal glands, 3 have remained well from four to seven years.

1 sarcoma, well four and a half years.

1 sarcoma, well four years.

1 small round-celled sarcoma, well seven years.

Of 18 cases of neoplasms primary in the axillary glands, 4 have remained well from three to nine years.

1 round-celled sarcoma, well three years.

1 round-celled sarcoma, well four years.

1 lymphosarcoma, well four years.

1 lymphosarcoma, well nine years.

One case of sarcoma of mediastinal glands has remained well six years.

Of 21 cases of Hodgkin's disease 1 remained well for seven months after complete disappearance of the disease under five weeks' toxin treatment. The patient refused further treatment and died of a recurrence one year later.

In the list of cases of other men (treated under my direction) one Hodgkin's case recovered, and remains well, at present, seven years later.

RECURRENCE AFTER APPARENT CURE WITH THE MIXED TOXINS

In a certain number of cases in which the tumor or tumors had entirely disappeared under the toxin treatment and the patients were apparently cured, the disease recurred at varying intervals from six months to six years. A study of these cases may be of some interest:

In one case, after a very large and rapidly growing primary neo-

plasm of the lymphatic glands had apparently entirely disappeared, the disease returned and progressed rapidly when the dose of the toxins was diminished, but began to decrease again and finally disappear under larger doses of the toxins. The patient is now well two years and a half.

In another case, a round-celled sarcoma of the tonsil with extensive metastases in the neck, the tumors entirely disappeared under six months' treatment with the mixed toxins; one and one-half years later a recurrence took place in the glands of the neck, which proved fatal within six months.

In a third case, a round-celled sarcoma of the tonsil and glands of the neck, the tumors having almost entirely disappeared under five weeks' toxin treatment, began to increase in size again when the dose was reduced. Under increased doses tumors completely disappeared. Six months later a recurrence took place which proved fatal within a year.

In another case still, a round-celled sarcoma of tonsil with extensive metastases in the neck, the disease entirely disappeared under eight weeks' toxin treatment. The patient remained well for six years, when a recurrence or a new tumor developed in the opposite tonsil; this tumor recurred very quickly after two operations and caused death within four months.

In one case, an intra-abdominal sarcoma primary in the mesenteric glands and small intestine, the disease entirely disappeared under four months' toxin treatment, then recurred one and one-half years later and proved fatal within six months.

In one case, an alveolar sarcoma, primary in the glands of the neck, the disease almost completely disappeared under four months' toxin treatment; the patient remained well for three years, when a recurrence took place; incomplete removal followed by the toxins and X-rays; patient well at present, six months later. In this case the tumor was pronounced adenocarcinoma by Dr. Ewing. December 1, 1915: There is evidence of mediastinal involvement.

Small round-celled sarcoma of the inguinal glands; complete disappearance under the toxins; recurrence, which again yielded to the toxins; the patient is well at present, seven years later.

In a recent case of recurrent inoperable sarcoma of the tonsil and neck, the tumors decreased to one-fourth their original size under six weeks' toxin treatment. Then the improvement ceased and the remaining tumor was removed by operation followed by toxin treatment which was kept up for about two months. The patient then left for a two weeks' vacation. Examination upon his return showed a recurrent tumor one inch in diameter at the site of the incision. He was again

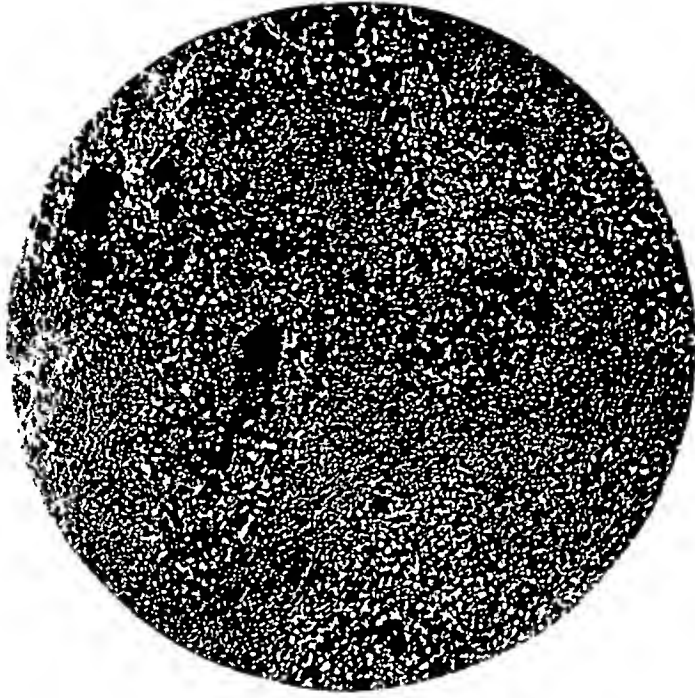


FIG. 1.—Case 21, Neck table. Lymphosarcoma of supraclavicular and retroperitoneal glands; very rapid progress. Patient died in three months.

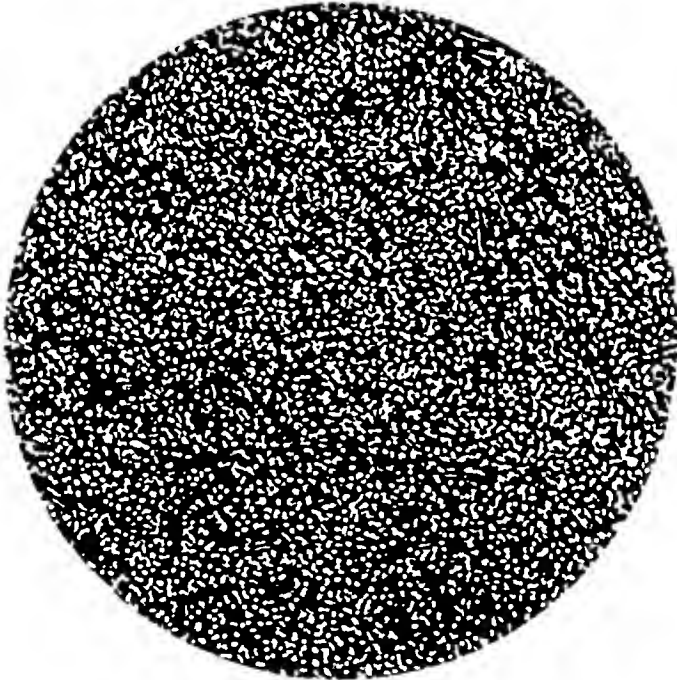


FIG. 2.—Hodgkin's disease; rapid course.



FIG. 3.—Clinical diagnosis was sarcoma of neck. Microscopical diagnosis was Hodgkin's disease.

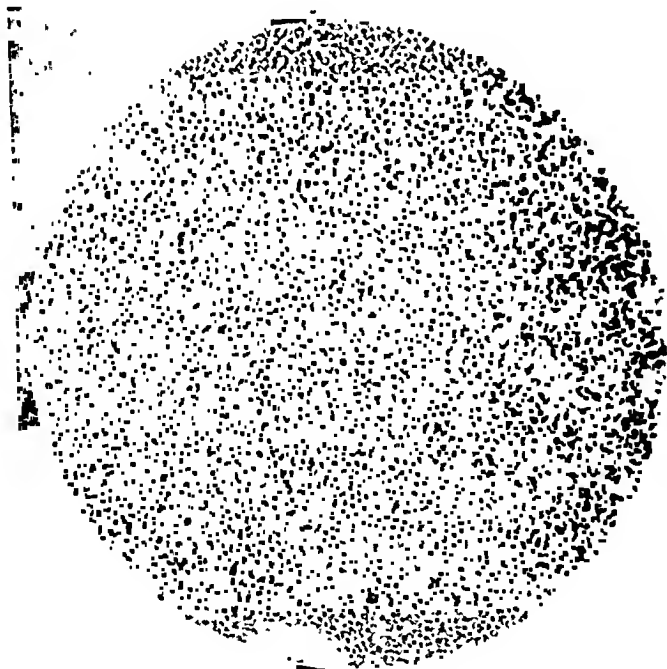


FIG. 4.—Hodgkin's disease.

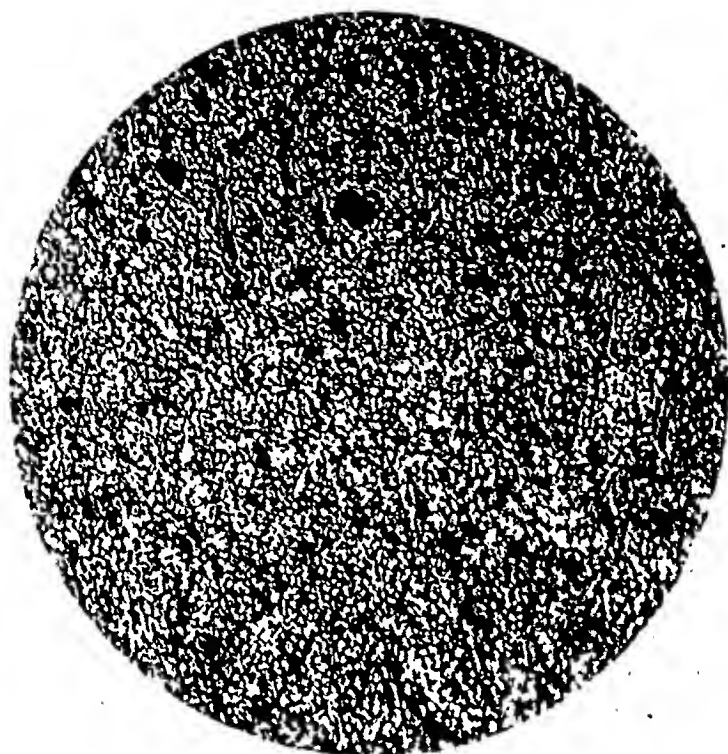


FIG. 5.—Case 3, Neck table. One pathologist pronounced specimen round-celled sarcoma; another reported atypical Hodgkin's disease.

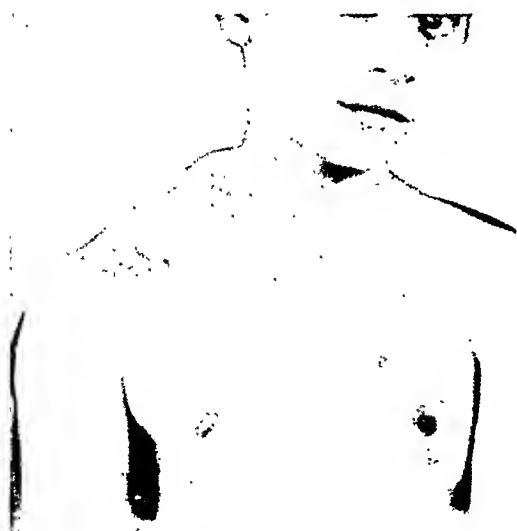


FIG. 6.—Pathological diagnosis was sarcoma, but clinical course was that of Hodgkin's disease.



FIG. 7.—Round-celled sarcoma.



FIG. 8.—Case 12, Neck table. Round-celled sarcoma of neck. Decreased three-quarters in one week, but later increased. Patient died four months later.



FIG. 9.—Round-celled sarcoma of neck.

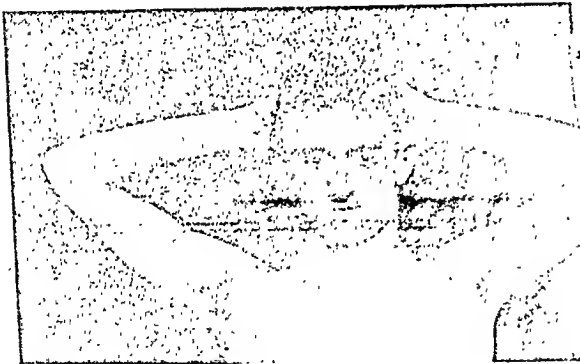


FIG. 10.—Hodgkin's disease.



FIG. 11.—Hodgkin's disease.



FIG. 12.—Lymphosarcoma of the neck. About thirty X-ray exposures before entering the hospital; no effect. Few treatments were given in hospital. Rapid progress.



FIG. 13.—Hodgkin's disease.

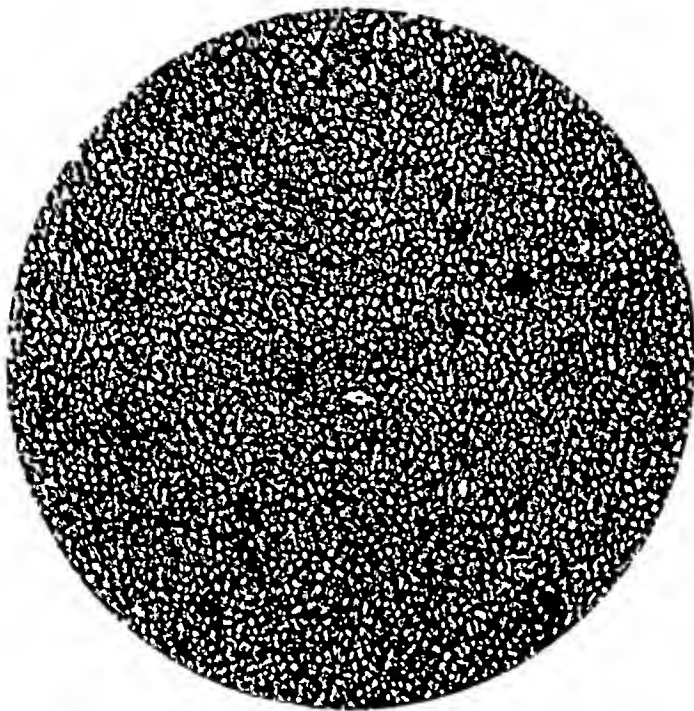


FIG. 14.—Lymphosarcoma.

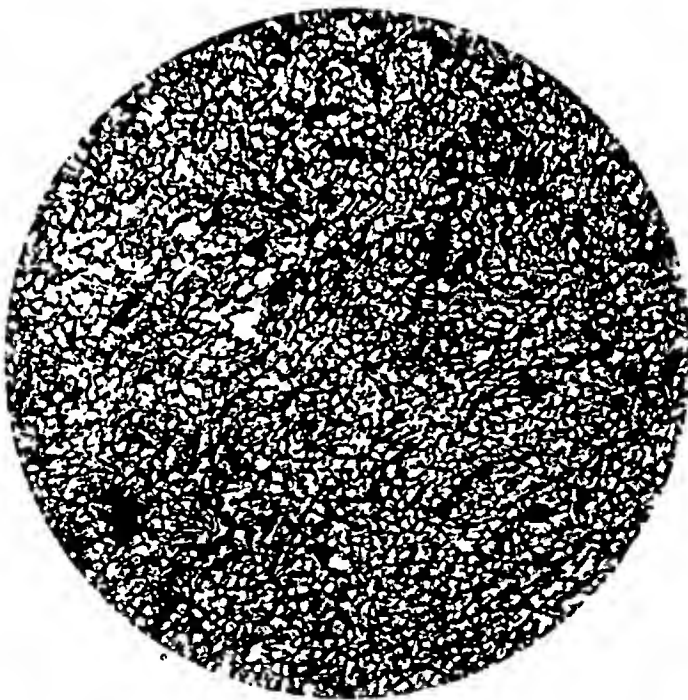


FIG. 15.—Lymphosarcoma of tonsil.



FIG. 16.—Lymphosarcoma of neck and tonsil.

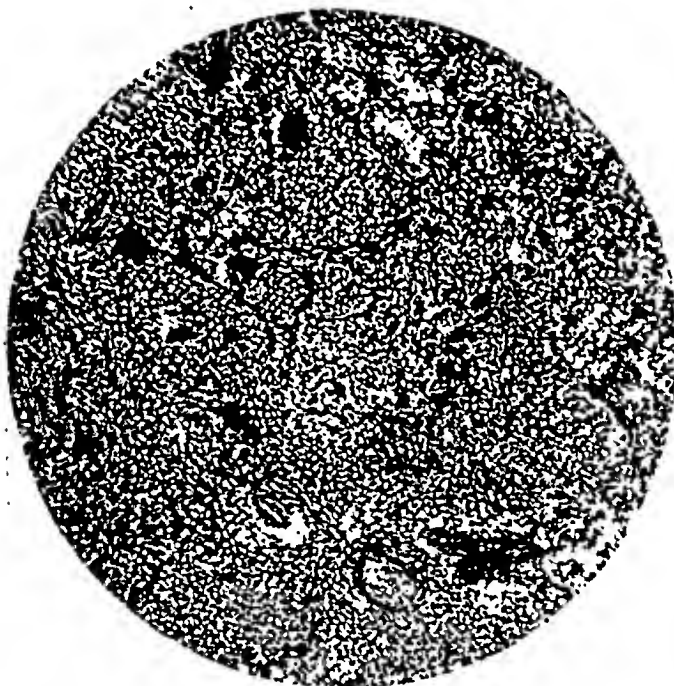


FIG. 17.—Inoperable recurrent sarcoma of neck. Entire disappearance under toxin treatment. Patient well at present, over six years later.

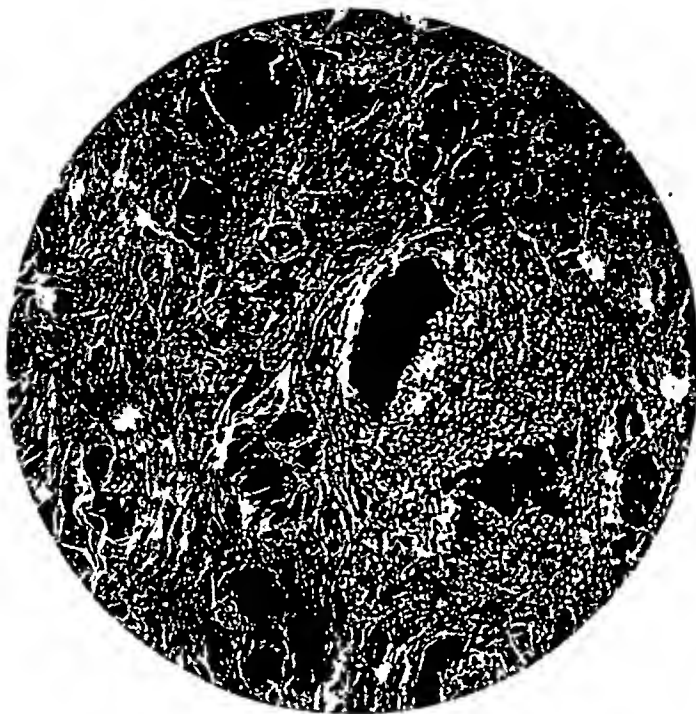


FIG. 18.—Recurrent sarcomatous (clinical diagnosis) glands of the neck; inoperable. Disappeared after use of toxins; well 2½ years, December, 1915.

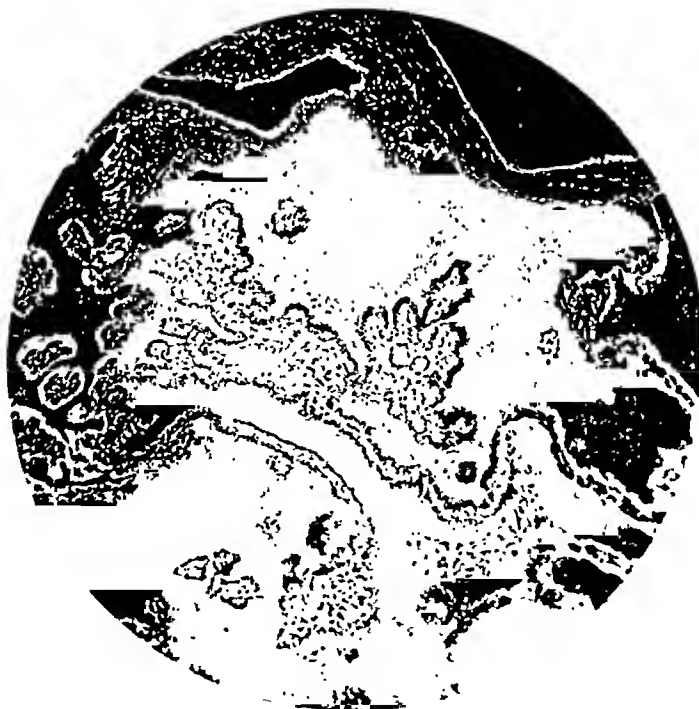


FIG. 19.—Case 17. Mr. K., Neck tube. Primary cervical glands. Papillary adenocarcinoma of neck (thyroid?). Same as Fig. 20.

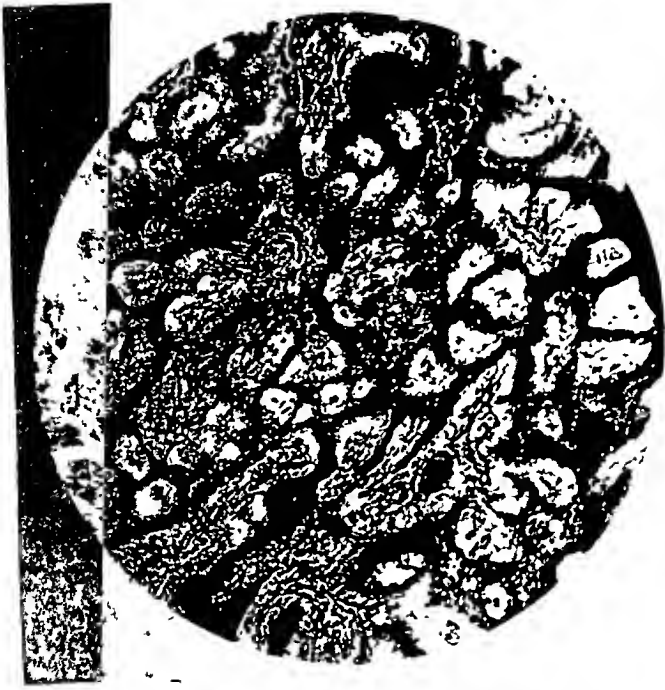


FIG. 20.—Mr. K. Angiopapillary endothelioma of neck.

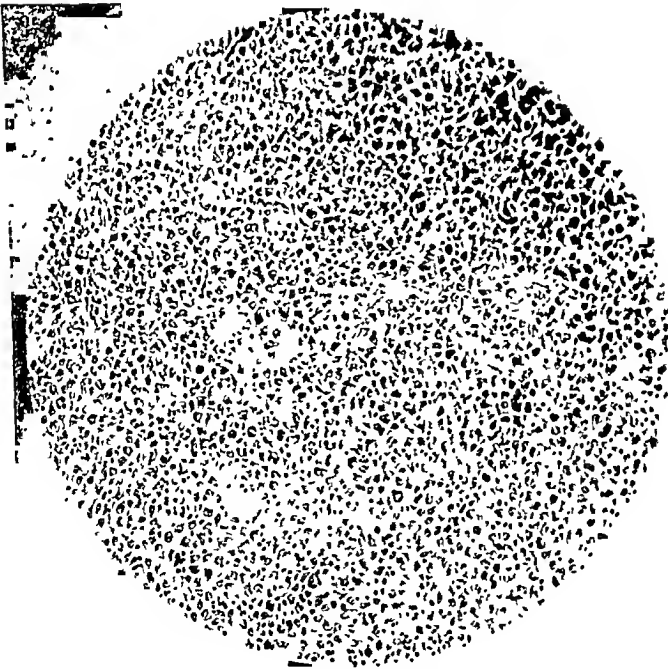


FIG. 21.—Lymphosarcoma of neck; recurrence after three operations; condition then inoperable. Entire disappearance and patient well at present 2½ years.



FIG. 22.—Sarcoma of neck.

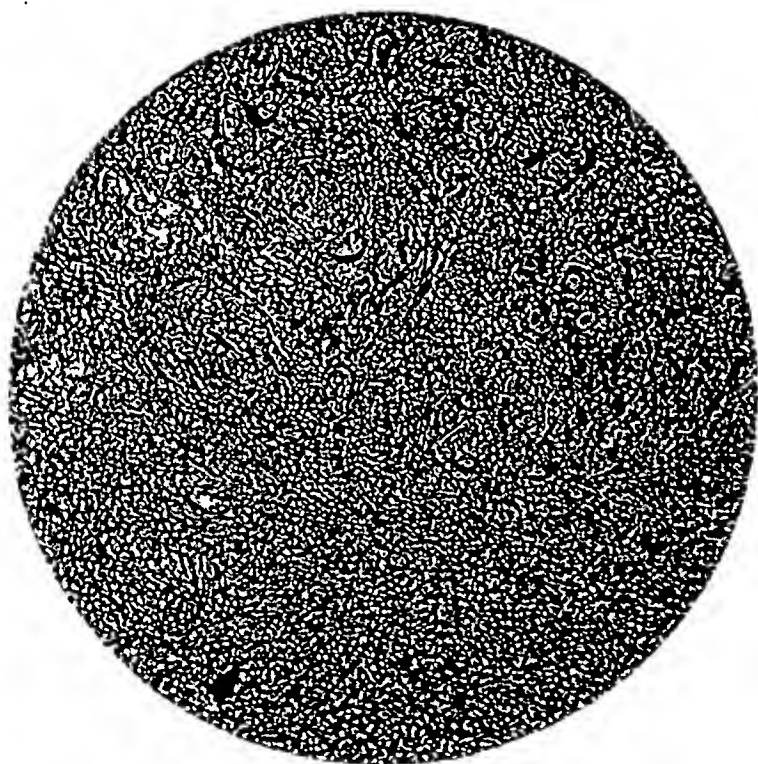


FIG. 23.—Same case as Fig. 22.

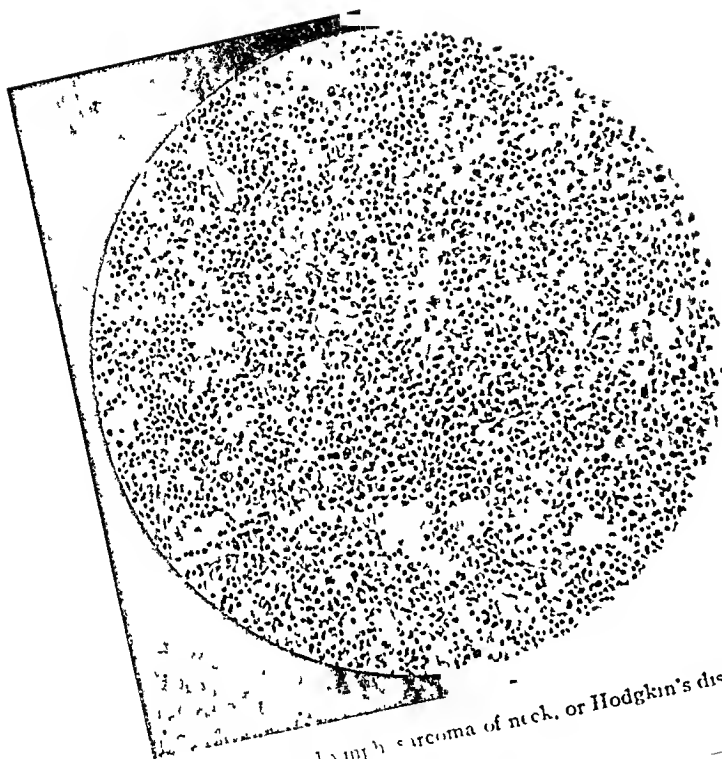


FIG 24 —Lymphosarcoma of neck, or Hodgkin's disease.



FIG 25 —Lymphosarcoma of tonsil and neck (Dr. Ewing and also Bellevue Hospital Laboratory).
Pure culture of diphtheroid bacillus obtained from gland in neck.



FIG. 26.—Axillary glands; rapid progress. One pathologist reported sarcoma; another melanoma.

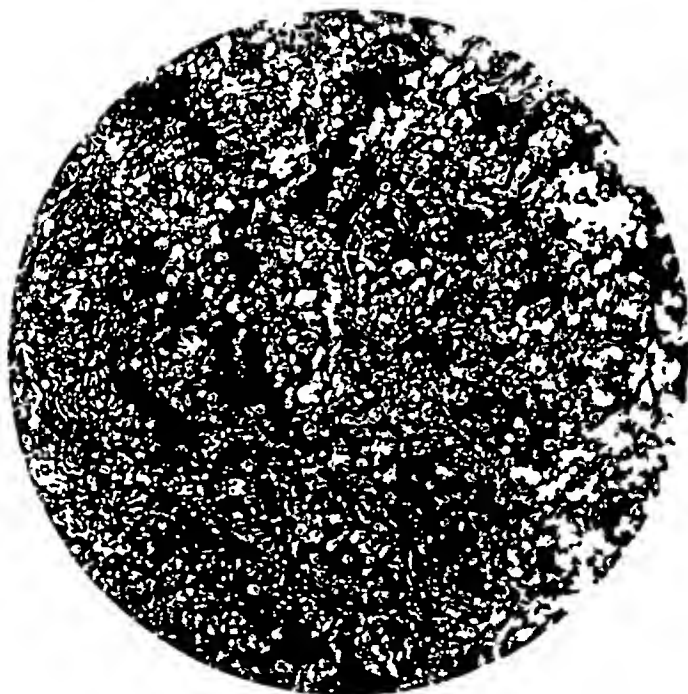
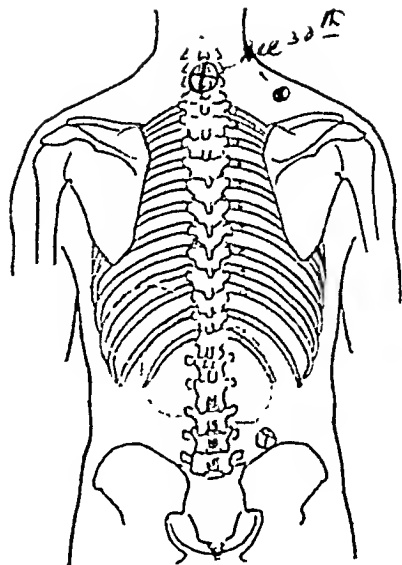
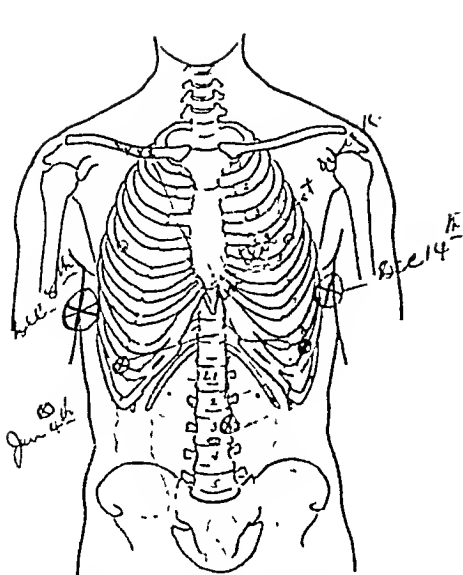


FIG. 27.—Melanoma; sarcoma of cervical glands; regarded as tuberculosis at first; two operations. Pathological report, melanoma. No primary pigment.



FIGS 28 and 29.—Lymphosarcoma beginning in axillary glands. Death in 3 months.

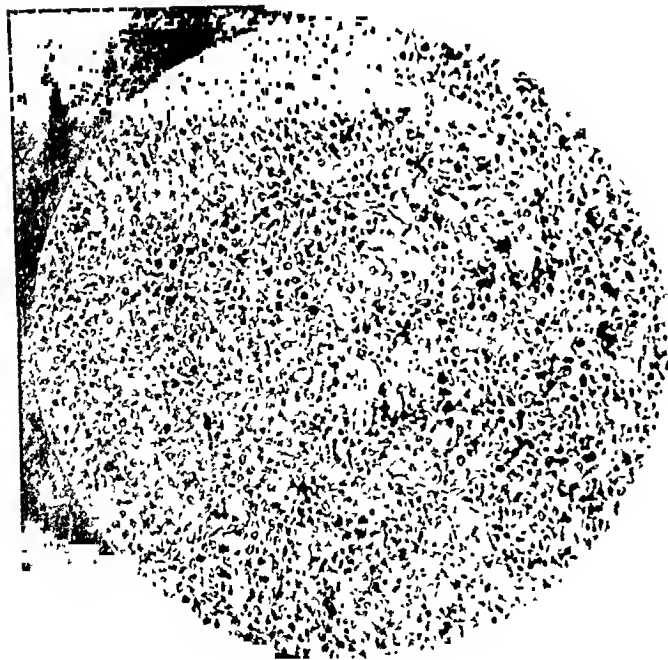


FIG. 30.—Lymphosarcoma of axillary glands or melanoma (Ewing). Death in 3 months.



FIG. 31.—Benign tumor of the lymphatic glands, of twenty-one years duration. Lympho-adenoma (Ewing). Probable Hodgkin's (Roosevelt Hospital diagnosis).

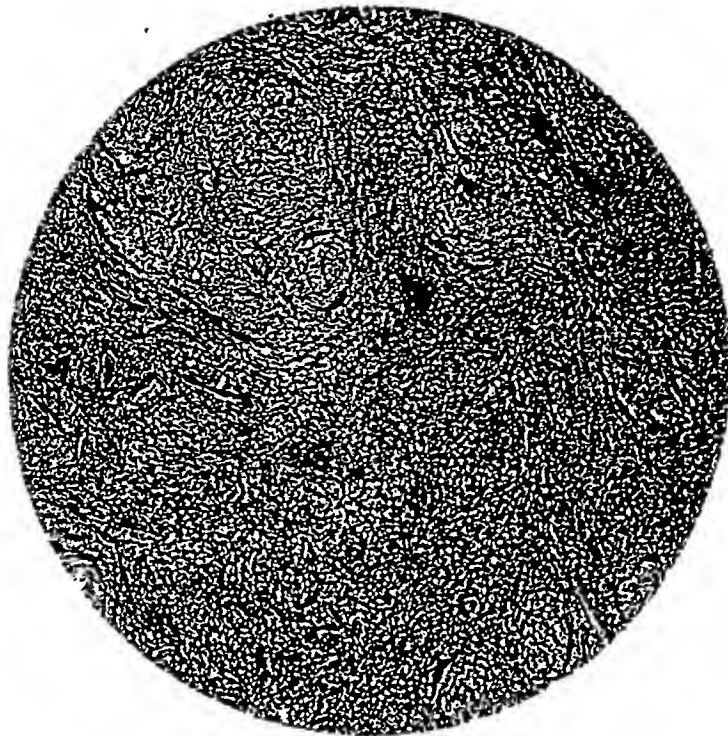


FIG. 32.—Neck case. Lympho-adenoma (Ewing). Hodgkin's (?), another diagnosis. Duration 21 years.

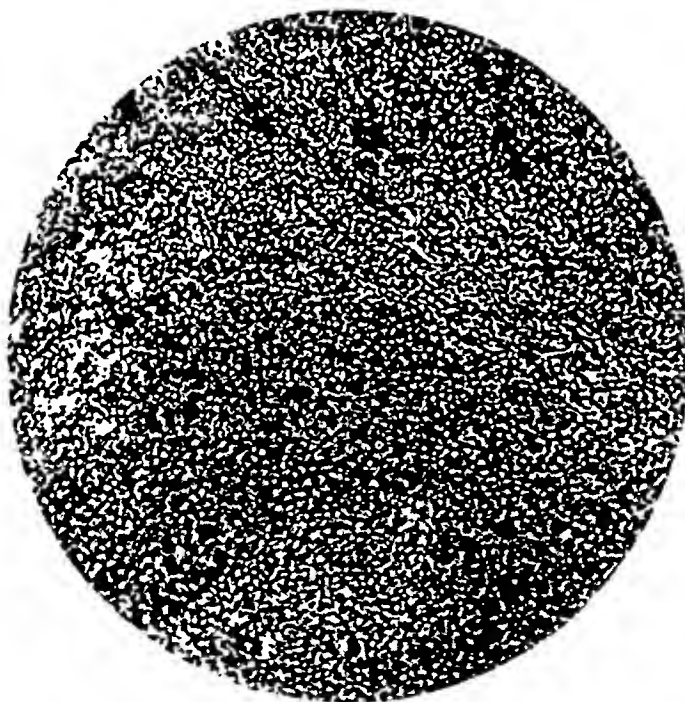


FIG. 33.—Case 15. Tonsil tissue. Before toxin treatment. Inoperable lymphosarcoma of tonsil and neck. Nearly disappeared after two months' toxin treatment, but then increased rapidly. Removed by operation, and toxin treatment again given. Improved under radium and X-ray; later recurred. Still under treatment.



FIG. 34.—Case 13, Tonsil table. After toxin treatment. Lymphosarcoma of tonsil and neck; after toxins. There was increase in fibrous tissue after 12 months' toxin treatment.



FIG. 35.—Case 13, Neck table. Tumor of carotid body.

PRIMARY NEOPLASMS OF LYMPHATIC GLANDS

put upon the toxins and while the disease was apparently held in check, there was no noticeable decrease in the size of the tumor. Under the combined toxin and radium treatment, which has been continued up to the present time, the tumor rapidly decreased in size and there is now scarcely more than an indurated edge at the site of the tumor. September 21, 1915: Local recurrence with cervical and mediastinal metastases has developed and general condition is rapidly growing worse in spite of continued toxin, X-ray, and radium treatment.

In connection with these recurrences, a brief reference to my first case treated with the living cultures of streptococcus of erysipelas in 1891, may be of interest: Inoperable spindle-celled sarcoma of the tonsil with extensive metastases on the neck; both primary and secondary tumors almost completely disappeared following an attack of erysipelas produced by inoculation in October, 1891. The patient remained well for eight years and then had a local recurrence which proved fatal within a year.

The most important lesson to be learned from a study of these recurrent cases I believe is that in many of them the treatment was not kept up sufficiently long.

I am convinced that it is better to continue the treatment longer than may be absolutely necessary in a certain number of cases, rather than run the risk of a recurrence by too short a course of treatment in certain other cases. In cases in which the toxins fail to control the disease I believe it advisable to use X-rays or radium or both in conjunction with the toxins.

A summary of the cases, 36 in number, successfully treated with the mixed toxins by other men, shows the following:

6 cases of sarcoma of the mesentery.

6 cases of sarcoma of the retroperitoneal glands.

17 cases of sarcoma of the neck.

3 cases of sarcoma of the tonsil and neck.

2 cases of sarcoma of the inguinal glands.

1 case of Hodgkin's disease (well seven years).

1 case of multiple sarcoma.

Of these 30 remained well from one to seventeen years.

21 remained well from three to seventeen years.

11 remained well from five to seventeen years.

7 remained well from twelve to seventeen years.

Most of these cases appear in tabulated form in my paper read before the Third International Conference of Cancer Research, Brussels, August 1 to 5, 1913.

TABLE OF 167 CASES OF PRIMARY NEOPLASM OF THE LYMPHATIC GLANDS INCLUDING HODGKIN'S DISEASE
NECK CASES

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|--------------|-----|-----|-----------|-------------------------|--------------------------------|---|--------------------------------------|--|--|---|--|
| 1 H. W.... | 55 | M | May, 1913 | Neck | No | Few weeks | Sarcoma | Round-celled sarcoma | Operation; rapid recurrence; toxins 3 months; second incomplete operation; toxins one year | Entire disappearance | Well at present, two and a half years. |
| 2 Dr. P. V.. | 40 | M | 1913 | Neck | ..... | A few months | Sarcoma | Infective granuloma; round-celled sarcoma | Operation; recurrence; toxins; disappearance. Recurred under small doses; again disappeared under large doses. Two operations; X-ray; toxins; temporary improvement; third operation, toxins | Improvement, reduction of dose, rapid growth | Complete disappearance; well at present, 2½ years. |
| 3 J. J. D... | 55 | M | 1913 | Neck | ..... | 16 months | Sarcoma | One pathologist, lymphosarcoma; Hodgkin's disease, another pathologist | Incomplete operation by Dr. Chas. Peck. Hopeless prognosis, given | Temporary improvement | Death in 1914; duration of life one year. |
| 4 P. K.... | 41 | M | 1909 | Neck | ..... | 2 months | Sarcoma | Small round-celled sarcoma. Dr. Hodenpyl, Roosevelt Hospital | Recurrent almost immediately and grew much more rapidly; soon extended into axilla; second operation (axilla) | Entire disappearance under three months treatment; mixed toxins | Well at present; 6 years. |
| 5 M. L. A.. | 40 | F | 1900 | Neck supraclavicular | ..... | 4 years, then grew rapidly after injury | Sarcoma | Round-celled (small) | First operation, 1908; second operation, 1911; March, 1912, inoperable recurrent tumors of neck and supraclavicular glands | Toxins begun Oct., 1900; marked improvement after 6 months; grew worse. X-ray used with great improvement | Improvement only temporary; died January, 1901; multiple metastasis. |
| 6 J. M.... | 27 | M | 1912 | Neck | ..... | 2 years | Supposed to be tuberculosis at first | Spindle-celled sarcoma | Very rapid involvement whole neck and side of face, in two months; daily temperature 102° | Toxins given with intervals of rest; 2½ years; marked improvement, able to work all of the time | Became rapidly worse; Nov., 1914, operation; cutting; died Dec., 1914 (extension into mediastinum and probably lungs). |
| 7 R. S.... | 21 | F | 1896 | Neck | ..... | 2 months | Sarcoma | Spindle-celled | | Toxins tried 6 weeks; slight decrease at first | Later, no effect; duration of life, from first symptoms, 5 months. |

| | | | | | | | | | | | |
|---------------|-----|---|------|-----------------|-------------------------|---|---------|---|---|---|--|
| 8 L. M.... | 24 | M | 1914 | Neck | ..... | Felt unwell, 8 months; noticed tumor 6 months | Sarcoma | Round-celled sarcoma (large cells) | First operation, April, 1914; recurred 6 weeks; tumor size of small egg; July 10, 1914, toxins begun | Tumor nearly disappeared in 3 weeks; later increased some | Removed by operation; grew very much more rapidly after operation; toxins used; little effect. |
| 9 J. H. R.... | 38 | F | 1909 | Neck | No | 7 months | Sarcoma | Lymphosarcoma | First operation, June, 1909; second operation, Sept., 1909; recurred; inoperable, Nov., 1909 | Huge infiltrating tumor, Nov., 1909 | Died few months later. |
| 10 J. R.... | 13½ | M | 1909 | Neck | No | 6 weeks | Sarcoma | Lymphosarcoma | First operation, Feb. 24, 1909; recurred, inoperable, April, 1909 | ..... | Died few months later. |
| 11 A. P.... | 2¾ | F | 1902 | Neck | No | 10 days | Sarcoma | Small round-celled. Dr. Steiner, pathologist, Hartford Hospital | First operation, January 27, 1902; second operation, few weeks later, March 8, 1902; whole neck involved, clavicle, and mastoid | Mixed toxins several months; no other treatment; entire disappearance | Well June, 1915; 13 years. |
| 12 A. W.... | 49 | M | 1894 | Neck | Repeated attacks quinsy | 6 months | Sarcoma | Small round-celled | Tumor size of large orange, no operation; tumor reduced to size of small egg | After 1 week's toxin treatment again began to increase, no further control | Died in 2 months. |
| 13 E. E.... | 35 | M | 1904 | Neck and tonsil | No | 4 months | Sarcoma | "Tumor of carotid gland" | Tumor, size of egg, pushing tonsil into pharynx | Removed by operation, incomplete operation | Not traced, probable death. |
| 14 C. H.... | 35 | M | 1912 | Neck | No | 5-6 years | Sarcoma | Round-celled sarcoma | First operation, July, 1910, very extensive; ligature common carotid; inoperable, very extensive tumor | Oct., 1912, toxins 6 months; marked improvement; later X-ray and toxins; nearly complete disappearance of tumor | Died 1914, acute nephritis. |
| 15 P. R.... | 44 | F | 1910 | Neck | No | 3 months | Sarcoma | Lymphosarcoma | First operation, Feb. 26, 1910; recurred in 9 weeks; June, 1910, tumor size of cocoonut | Toxins tried 3 weeks, no effect | Death few months later. |

NECK CASES—Continued

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|------------------|-----|-----|------|------------------|--------------------------------|----------------------------|---------------------|---|--|---|---|
| 16 M.W.B. | 20 | F | 1910 | Neck | No | 1 year | Sarcoma | Exploratory operation; specimen pronounced negative | Very large tumor involving whole side of neck and extending into mediastinum | Toxins, 6 months; radium and X-ray continued; slow increase in size | 1 year ago (1914) began to decrease in size; now 1/2 size of 2 years ago. |
| 17 K..... | 43 | M | 1911 | Neck | ..... | 15 months | ..... | Round-celled angiosarcoma, one pathologist, primary tumor; adenocarcinoma; recurrent tumor, Dr. Ewing | Incomplete operation, toxins | Almost complete disappearance; well 3 years; recurrence; operation and toxins and X-ray | Well nearly 1 year. Nov., 1915. Recurrence in mediastinum. |
| 18 M..... | 42 | M | 1898 | Neck | ..... | 1 1/4 years | Sarcoma | Round-celled | Inoperable | Toxins, but little effect | Died in a few months. |
| 19 M..... | 30 | M | 1903 | Neck | ..... | 10 months before operation | Sarcoma | Round-celled sarcoma (first operation, diagnosis tubercular) | First operation, Nov., 1902; second operation, Feb., 1903; third operation, July, 1903; recurred and grew very rapidly | Oct. 1, 1903, enormous infiltrating tumor; X-ray tried | No effect; prognosis hopeless. |
| 20 T. M... | 21 | M | 1907 | Neck | ..... | 4 years before operation | Sarcoma | Small round-celled | First operation, 1902; small lump appeared in a few months; remained some 4 years, then grew rapidly | Toxins, 22 doses; unimproved | Died later. |
| 21 H..... | 38 | M | 1914 | Neck and abdomen | ..... | 3 weeks | Sarcoma | Round-celled sarcoma (Dr. Ewing) | Enlarged glands in suprasternal region, also large mass in abdomen; probably retroperitoneal | No operation; toxing 3 weeks; considerable decrease in size | Later no effect; Death in 2 months; whole duration of disease, 4 months. |
| 22 L. S... | 28 | M | 1912 | Neck | ..... | 3 months | Sarcoma | First microscopic examination, hyperplasia; second, hyperplasia | First operation, Jan., 1912; second operation, April, 1912; tumors quickly recurred | Sept. 18, 1912, large inoperable tumor; clinical appearance typical of sarcoma | Died within 1 year. |
| 23 L. S....adult | | F | 1911 | Neck | ..... | Few months | Sarcoma | Polymorphous sarcoma (lymphosarcoma) | First operation, May 13, 1911; tumor size of fist removed; incomplete operation | ..... | Death within few months. |

| 24 Mrs. B. | 60 | F | 1905 | Neck | After strain of neck | 1 year | Sarcoma | Fibrosarcoma | Incomplete operation, Feb., 1905; toxins | ..... | Death. |
|------------|----|---|------|------|----------------------------|-----------|---|---|---|--|--|
| 25 G..... | 25 | M | 1910 | Neck | Followed grippe cold | 3 months | Sarcoma (thought to be tubercular at first) | Sarcoma (Mayo Clinic) | Inoperable tumors, cervical and axillary region; toxins begun Oct., 1910 | Axillary tumors reduced one-half in size; some loss of flesh | Improvement temporary; died within 1 year. |
| 26 B..... | 55 | M | 1913 | Neck | Frequent attacks of quinsy | 9 months | Sarcoma | Sarcoma or carcinoma (Ewing), section too thick | Inoperable tumor, size of fist; whole left cervical region | Toxins, 3 weeks; decrease in size; increased mobility | Soon grew worse and died Dec. 20, 1913. |
| 27 A..... | 41 | M | 1907 | Neck | No | 1 month | Sarcoma | Round-celled | First operation, Aug., 1905; recurred in 6 months; second operation, March, 1906; recurred Jan., 1909 | ..... | Died. |
| 28 C..... | 41 | M | 1911 | Neck | No | 4 months | Sarcoma | Round-celled | Exploratory operation, Sept. 15, 1911 | Inoperable; toxins few weeks; temporary improvement | Not traced. |
| 29 B..... | 22 | M | 1908 | Neck | Bad teeth | 4 months | Sarcoma | Sarcoma | Recurred 3 weeks; operation Dec., 1907 | Feb., 1908, inoperable | Died Sept. 8, 1908. |
| 30 C..... | 49 | F | 1899 | Neck | No | 5 years | Tubercular glands at first | Sarcoma | First operation, 1894, by Dr. Morris; second operation in 4 months; third operation in 2 years | January, 1899, inoperable, very large | Died within year. |
| 31 M..... | 56 | M | 1913 | Neck | No | 1 year | Sarcoma | Sarcoma, lymphosarcoma (Mayo Clinic) | Several operations, 1912-1913; inoperable, June, 1915 | Recurrence, inoperable; toxins tried 6 weeks; little effect | Death in 6 months. |
| 32 M..... | 44 | M | 1896 | Neck | No | 1 year | Sarcoma | Round-celled | First operation, 1894; Dr. Mixer (called tuberculosis); second operation 6 months later; third operation 6 months later | Called tuberculosis up to fourth operation, then round-celled sarcoma | Toxins, temporary improvement; died. |
| 33 P..... | 20 | M | 1900 | Neck | No | Few weeks | Sarcoma | Sarcoma | First operation Sept., 1899; small single tumor removed under angle of jaw; recurred in 3 weeks; grew rapidly | April, 1910, large inoperable, recurrent tumor; size of coconut; toxins, few weeks | Little improvement, died later, within 6 months. |
| 34 N..... | 40 | M | 1911 | Neck | No | 2 years | Sarcoma | Lymphosarcoma | Small nodule, quiescent 2 years, then sudden, rapid enlargement; operation, Feb. 11, 1911 | Recurred in 3 weeks; April 13, 1911; large inoperable, whole right side neck; toxins | Very little improvement, died later. |

NECK CASES—Continued

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|-----------|-----|-----|------|----------|--|--|---|--|--|---|--|
| 35 C..... | 4 | F | 1906 | Neck | No | 7 months | Supposed to be fatty tumor at first; back of neck | Small, rounded sarcoma | First operation, March, 1906; second operation, August, 1906; 10 injections of toxins after second operation; third operation, Nov., 1906; toxins | Recurrence after each operation | Died, fall, 1907; probably cerebral sarcoma. |
| 36 C..... | 38 | M | 1902 | Neck | No | 6 months | Supposed to be tubercular at first; operation | Lymphosarcoma | First operation, Sept., 1901; curetting softened gland; rapid recurrence; second operation very extensive, Feb., 1902 | Sept., 1902, very large inoperable tumor entire, supraclavicular and cervical regions | Forty X-ray, no effect; then took toxins; no effect; died shortly after. |
| 37 C..... | 37 | M | 1908 | Neck | No | Symptoms 6 months; tumor 2 months | Tumor | Lymphosarcoma (Dr. Whitney, Harvard) | Inoperable tumor, supraclavicular, June 8, 1908; toxins | Little effect | Death within 1 year. |
| 38 C..... | 51 | M | 1908 | Neck | No | 3 months | Tuberculosis after first operation | Spindle-celled sarcoma | First operation, July, 1908; X-ray used three times a week; very powerful tubes; no effect on rapid growth of tumor, Sept., 1908; tumor size of fist, inoperable; loss of weight | Toxins brief period, little effect | Died Sept., 1908. |
| 39 K..... | 49 | M | 1899 | Neck | Blow on neck from board, 4 months before | Tumor stationary 2 years, then grew; both sides neck | Sarcoma | Lymphosarcoma | Inoperable when first seen; electric treatment 6 months, no effect | ..... | Died. |
| 40 C..... | 44 | M | 1912 | Neck | Stiff neck year before | 5 months | Lymphosarcoma | Malignant tumor—exact nature could not be determined | Local treatment, later toxins | Temporary improvement | Died in a few months. |
| 41 L..... | 28 | M | 1899 | Neck | No | 2 months | Began right submaxillary gland; both sides, later | Lymphosarcoma | Toxins | Toxins, one week; little effect | Died within 1 year. |

| | | | | | | | | | | | |
|-----------|----|-----------|------|-------------------------|----------------------------|-------------------------------|--|----------------------|---|--|--------------------------------|
| 42 H..... | 49 | F | 1906 | Neck | No | 2 years | Began in single gland, then several fused in large tumor | Lymphosarcoma | No operation; inoperable; X-ray prolonged treatment, no effect; toxins given 1 month, no effect | No effect | No effect; died within 1 year. |
| 43 D..... | 60 | M | 1898 | Neck | No | 4 months, back of neck | Sarcoma | Lymphosarcoma | Inoperable when first seen | Toxins, 4 | Little effect; death. |
| 44 O..... | 27 | M colored | 1900 | Neck | No | 1 year | Sarcoma | Lymphosarcoma | Tumor size of 2 fists, freely movable; operation (Dr. Coley), May 12, 1900 | No other treatment; well 4 months later | Not traced. |
| 45 Y..... | 22 | M | 1899 | Neck | No | 18 months | Sarcoma | Lymphosarcoma | Aug. 4, 1899; tumor one-half size cocoonut; inoperable | ..... | Died. |
| 46 L..... | 19 | M | 1909 | Neck | No | 1 year | Sarcoma | Lymphosarcoma | First operation, Dr. Vander Veer, Dec. 1, 1908; second operation, March, 1909; May 26, 1909, inoperable; recurrence | ..... | Died. |
| 47 M..... | 21 | M | 1907 | Neck | No | 3 months (both sides neck) | Sarcoma | Round-celled sarcoma | First operation, June, 1906; June, 1907, inoperable recurrence; treated at General Memorial Hospital, 1907; toxins + X-rays | Marked decrease in size at first | Later no effect. |
| 48 B..... | 56 | F | 1910 | Neck (supra-clavicular) | Yes, struck by windlass | Pain 2 months before swelling | Sarcoma | Round-celled sarcoma | Operation, Feb., 1910; Dr. Da Costa; toxins begun July, 1910; kept up 2 months | Little effect | Died Oct. 1, 1910. |
| 49 S..... | 15 | F | 1899 | Neck | No | 2 months | Sarcoma | Lymphosarcoma | Operation Oct., 1899; Mt. Sinai Hospital; tumor size orange | Local recurrence, inoperable, Dec., 1899 | ? |
| 50 S..... | 58 | M | 1910 | Neck | Followed severe cold | 6 months | Sarcoma | Lymphosarcoma | Jan. 19, 1910; inoperable, whole left side, neck, mastoid and clavicle | ..... | Died within 1 year. |
| 51 W..... | 46 | F | 1909 | Neck (supra-clavicular) | Blow from a falling window | Tumor 1 week after blow | Sarcoma | Lymphosarcoma | Toxins begun spring, 1909; 78 injections prior to July 12, 1909 | Marked decrease in size | Died about 1 year later. |

NECK CASES—Continued

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|---------------|-----|-----|------|----------|--------------------------------|---|-----------------------|--------------------------|--|---|---|
| 52 W. | 37 | F | 1905 | Neck | No | 1 month | Sarcoma | Round-celled | Operation, Dr. Woolsey, Aug. 9, 1905; wound never healed; rapid recurrence | Recurrence, Dec., 1905; whole side of neck involved, very large infiltrating tumor; toxins, little effect | Died shortly after. |
| 53 V. | 46 | M | 1908 | Neck | No | 9 months | Sarcoma | Round-celled | Operation, Dr. Blake; January, 1908; recurred in 2 weeks | Inoperable | Death within few months. |
| 54 V. P. | 37 | M | 1902 | Neck | No | 6 months | Sarcoma | Round-celled | Operation, Nov., 1902 | Inoperable recurrence and toxins; X-ray, Dec. 25, 1902; little effect | Death within few months. |
| 55 S. | 31 | F | 1911 | Neck | No | 1½ years | Sarcoma | Round-celled | Operation Oct., 1910; inoperable | Recurrence, April 12, 1911; toxins; little effect | Death. |
| 56 S. | 29 | M | 1912 | Neck | No | 6 weeks | Sarcoma | Mixed-celled | Operation, Dr. Howe, Hartford, April 8, 1912; incomplete removal; rapid growth; July 3, 1912, inoperable; toxins | Temporary improvement | Died within a year. |
| 57 S. | 28 | M | 1900 | Neck | Strain muscles of neck | Pain at once; continued; tumor 4 months | Sarcoma, round-celled | Sarcoma | First operation, Sept. 6, 1899; recurred soon after | Recurrence; April 13, 1900, inoperable tumor, size 2 fists firmly fixed; toxins | Little effect; death in one year. |
| 58 W. | 58 | M | 1908 | Neck | No | 2 years | Sarcoma | Round-celled | First operation, Nov. 1908; Dr. Gray, of Lynn, Mass.; incomplete operation | Dec. 21, 1908, inoperable recurrence; toxins begun and continued 3 months | Entire disappearance; patient well, June, 1915; 6½ years. |
| 59 R. | 43 | M | 1907 | Neck | No | 6 months | Sarcoma | Spindle-celled | First operation, Jan., 1906; second operation, Jan., 1907; July, 1907, inoperable recurrence; ligature common carotid; toxins, 20 injections | Very little improvement | Died few months later. |

| | | | | | | | | | | | |
|-----------|----|---|------|---------------------------|--|-------------------------------------|-----------|---|--|--|---|
| 60 L..... | 26 | F | 1899 | Neck | No | 5 months | Sarcoma | Lymphosarcoma | First operation, May, 1899; second operation, Sept., 1899; recurred both sides; rapid growth | Oct., 1899, inoperable; hopeless condition | Death soon after. |
| 61 G..... | 47 | M | 1899 | Neck, supra-clavicular | No | 9 weeks | Sarcoma | Lymphosarcoma | Inoperable tumor, supraclavicular; severe pain in arm, pressure on nerves; marked loss power right arm and leg; no operation | ..... | Death. |
| 62 G..... | 41 | M | 1910 | Neck | No | 3 months | Sarcoma | Lymphosarcoma | First operation, June, 1910; second operation, July, 1910 | Recurrence; toxins, marked improvement; later operation | Final result not known. |
| 63 S..... | 53 | M | 1914 | Neck | ..... | ..... | Sarcoma | ..... | ..... | Metastases in brain | Death. |
| 64 S..... | 18 | M | 1914 | Neck | No, tonsillitis | Pain 2 years, lump in neck 1½ years | Sarcoma | Sarcoma | Operation, Jan., 1914 | Recurrence; toxins, April, 1914, 1 month | Unimproved. |
| 65 W..... | 19 | M | 1913 | Neck and mediastinum | No | ..... | Sarcoma | ..... | Toxins + X-ray | Temporary improvement | Death within 4 months. |
| 66 D..... | 19 | F | 1915 | Neck | No | 2 months | Sarcoma | Tumor, thymus gland | Two operations | No improvement | Died in 3 months. |
| 67 J..... | 31 | M | 1908 | Neck | No Sprain from lifting heavy weight | 4 days | Hodgkin's | Sarcoma; Prof. Potter, Cornell University, Ithaca | First operation, Feb. 7, 1905; rapid recurrence; second operation, May, 1905; local recurrence and axillary glands; X-ray after second operation; liver enlarged, but not spleen | Temporary improvement | Died Sept. 1, 1908. |
| 68 J..... | 9 | M | 1912 | Neck | Followed attack of the measles in 1910 | ..... | Hodgkin's | 1912, sarcoma; Coll. P. and S. 1914, Dr. Ewing, simple lymphoma | Gland removed for microscopical examination, 1912; toxins begun Oct., 1912; severe reactions | Glands all disappeared; recurred in spring, 1914; toxins again started | Almost entire disappearance under 4 months' toxin treatment; well Dec. 1, 1915. |
| 69 M..... | 43 | F | 1914 | Submaxillary region; neck | ..... | 2½ years | Sarcoma | Chronic adenitis, first operation; tuberculosis; second operation; third operation; melanotic sarcoma; fourth operation, melanoma, malignant; fifth operation, melanoma | Four operations; recurrence, toxins; decrease in size, rendering fifth operation, partial, feasible; followed by toxin treatment | Recurrent after 4 operations, toxins; decrease in size, partial operation followed by toxins | So far free from recurrence; still under treatment, Nov., 1915. |

NECK CASES—Continued

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|-------------|-------|-----|-------------|---|--|------------|---------------------|--|--|---|---|
| 70 B. | Adult | M | 1911 | Neck and tonsil | No | Few months | Sarcoma | Lymphosarcoma, Mt. Sinai Hospital | Glands removed, 1908; X-ray | Tumor disappeared, April, 1911; signs of metastasis in abdomen; Aug., 1911, enlarged spleen and liver and inguinal glands | Death in few months. |
| 71 McN. ... | 60 | F | May, 1915 | Neck | ..... | 6 months | Sarcoma | Spindle-celled sarcoma | Operation, recurrence, toxins | Disappearance under 3 weeks' toxin treatment | Still under treatment, no evidence of a return Dec. 15, 1915. |
| 72 J. | .. | F | 1913 | Neck | ..... | 3 months | Sarcoma | Simple lymphoma; chronic lymphadenitis; sarcoma | Two operations, recurrence; radium | Slight temporary improvement | Death one year after onset. |
| 73 L. | 31 | M | Nov. 1908 | Neck | Seantling fell 6 feet, striking neck, subject to tonsillitis | 2 years | Sarcoma | Lymphosarcoma by one pathologist; endothelioma by another; later, lymphoma | Operation; toxins | Remained well for 6 months, then recurrence; toxins and various vaccines tried without avail | Died Nov. 5, 1910. |
| 74 H. | 70 | M | May, 1901 | Neck | ..... | 10 years | Sarcoma | General round-celled sarcoma | Five operations held growth in check for 10 years, then X-rays | Final disappearance | Two years later, recurrence which caused death. |
| 75 G. | 56 | M | June, 1915 | Neck | ..... | 21 years | Sarcoma | Lympho-adenoma, Dr. Ewing; granuloma, probably Hodgkin's, Roosevelt Hospital | Operation 15 years ago; recurrence, X-ray treatment; vaccine treatment | No improvement | Still under X-ray treatment. |
| 76 M. | 53 | F | March, 1896 | Submaxillary region; also carcinoma of breast | ..... | 4 months | Typical sarcoma | Glandular hyperplasia; later, round-celled sarcoma | Inoperable, became operable under toxin treatment | Recurrence 4 months later, operation again followed by recurrence; very rapid growth | Died March 18, 1897, from exhaustion. |

SARCOMA OF TONSIL AND NECK

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|----------|-----|-----|-------------|-----------------|--|--|---------------------|---|---|---|--|
| 1 W..... | 56 | M | May, 1910 | Tonsil and neck | No trauma; smoker | Noticed 2 months; tonsil and cervical glands | Sarcoma | Round-celled sarcoma | Inoperable; portion removed for microscopical examination | Entire disappearance of tumors | Patient alive, no recurrence 5½ years later. |
| 2 S..... | 55 | M | Nov., 1909 | Tonsil and neck | Followed tonsillitis, temperature 102°-103° | 2 weeks | Sarcoma | Lymphosarcoma | Inoperable; gland removed for microscopical examination; one dose toxins, ¼ minim | Condition did not warrant continuing | Death 2 days later. |
| 3 Z..... | 29 | M | April, 1914 | Tonsil and neck | Followed tonsillitis 5 months ago | 5 months | Sarcoma | Lymphosarcoma from specimen of neck; autopsy diagnosis lymphatic leukemia | Toxins, autogenous vaccines and X-ray | No improvement | Death, June 28, 1914; autopsy, Dr. Ewing. |
| 4 M..... | 25 | M | July, 1911 | Tonsil and neck | No history of tonsillitis | 5 months | Sarcoma | Sarcoma | Inoperable | ..... | Death. |
| 5 F..... | 42 | M | May, 1914 | Tonsil and neck | No history of tonsillitis, negative Wassermann | 1 year | Sarcoma | Round-celled sarcoma, tonsil and neck (Dr. Ewing) | Inoperable, mixed toxins, 4 weeks | Very marked decrease in size; recurred 2-3 weeks later; toxins lost control | Death July, 1914. |
| 6 M..... | 43 | F | May, 1913 | Tonsil and neck | Subject to tonsillitis | 3 months | Sarcoma | Lymphosarcoma | Inoperable, 7 injections of toxins | No effect | Not traced. |
| 7 D..... | 53 | F | 1896 | Tonsil and neck | No | Few weeks | Sarcoma | ..... | Operation tonsil, neck 3 months; inoperable | ..... | Died. |
| 8 D..... | 52 | M | 1909 | Tonsil and neck | No | 2 years | Sarcoma | Sarcoma | Toxins begun and kept up for six months | Entire disappearance | Patient well, Nov., 1915; nine years. |

SARCOMA OF TONSIL AND NECK—Continued

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|------------|-----|-----|-----------|-------------------|--|--|---------------------|---------------------------------|--|---|---|
| 10 McA.... | 24 | M | 1912 | Tonsil and neck | Following severe cold | Few months | Sarcoma | Lymphosarcoma | Toxins, 3 months; temporary improvement, vaccines and diphtheroid bacillus cultures; temporary improvement; X-ray, temporary improvement Section removed for diagnosis; toxins, June 29, 1913 | Temporary improvement | Later very rapid growth; death, general metastases, 8 months from beginning of treatment. |
| 11 O..... | 24 | M | 1913 | Tonsil and neck | No | 10 months | Sarcoma | Large round-celled sarcoma | Incomplete operation, tonsil and neck, Aug., 1905; rapid recurrence, inoperable tumor, neck and tonsil, size of orange, Oct., 1905; toxin treatment | Marked decrease in size | Temporary only. |
| 12 M..... | 32 | M | 1905 | Tonsil and neck | No | 1 month before operation | Sarcoma | Round-celled sarcoma | Operation, local recurrence soon after; inoperable Feb. 19, 1915; toxins | Entire disappearance in 8 weeks; recurred other tonsil 6 years later | Died 4 months after recurrence. |
| 13 C..... | 43 | M | 1915 | Tonsil and neck | No | 6 months before first operation | Sarcoma | Lymphosarcoma | Operation by Dr. J. L. Erdmann; recurred, inoperable; toxins 2 months | Tumor reduced to 1/4 original size in 6 weeks; improvement, then ceased; remainder removed by operation | Recurrence; tumor rapidly decreasing in size under toxin and radium treatment; still under treatment. |
| 14 L..... | 47 | M | May, 1913 | Tonsil and neck | No | ..... | Sarcoma | Lymphosarcoma | Toxins, May 29, 1906; large doses | Temporary improvement | Died 6 months later. |
| 15 C..... | 42 | M | 1906 | Tonsil and neck | Followed severe cold | 5 months; marked loss of weight | Sarcoma | Round-celled; inoperable | First operation, Oct., 1905; immediate local recurrence; second incomplete operation; toxins | Entire disappearance 6 months; recurred 1 1/2 years later; rapid growth | Death 6 months after recurrence. |
| 16 P..... | 66 | M | 1905 | Tonsil, no glands | No | 1 month before operation | Sarcoma | Sarcoma, Dr. Leonard, of Boston | Sep. 22, 1908; very large inoperable tumor of tonsil and whole right cervical region; toxins short time | Not traced | Not traced. |
| 17 S..... | 63 | M | 1908 | Tonsil and neck | Followed attack of tonsillitis 1 week before | 1 week, very rapid growth; inoperable in 2 weeks | Sarcoma | ..... |  | Little effect | Died few months later. |

| 18 C. | 51 | M | 1900 | Tonsil and neck | No | 11 year | Sarcoma | Sarcoma | First operation 11 years before; local return soon, slow growth; second op- eration 5 years later; recurrence in 3 years; third opera- tion, Aug., 1898; March, 1900, inop- erable; local recur- rence | Recurrent after 3 operations | Died. |
|------------|-------|---|------|--------------------|----|---|---------|--|--|---|--|
| 19 H. | Adult | M | 1914 | Tonsil and neck | No | 5 months | Sarcoma | Lymphosarcoma, glands, neck; round-celled sarcoma, tumor of tonsil | First operation Feb. 28, 1913, Mayo's Clinic; glands of neck removed; sec- ond operation 2 months later, Mayo Clinic; encapsulated tumors of tonsil re- moved, May, 1914; block dissection of neck, followed by toxins; slight recur- rence noted; toxins continued at home | Recurrence after 3 operations | Died. |
| 20 W. | 49 | M | 1898 | Tonsil and neck | No | 3 months | Sarcoma | Sarcoma | Incomplete opera- tion; swelling of glands few days later; Dec., 1898, tumors of tonsil and neck; inoperable, later size of fist | Recurred | Death in few months. |
| 21 C. | 48 | F | 1895 | Tonsil and neck | No | Oct., 1894, no- ticed en- larged tonsil | Sarcoma | Round-celled sar- coma | First operation, Oct., 1894; second opera- tion, April, 1895; recurrence, rapid increase in size; toxins 4 weeks injections | No improvement | Death few months later. |
| 22 R. | 19 | M | 1913 | Tonsil | No | ..... | Sarcoma | Large round- celled lympho- sarcoma | Inoperable; toxins, 48 | No improvement. | |
| 23 F. | 19 | M | 1914 | Tonsil and neck | No | 2 months; right side; 1 month, left | Sarcoma | Lymphosarcoma | Radium and X-ray treatment and re- moval of tonsils | | |
| 24 Z. | 31 | M | 1891 | Tonsil and neck | No | 1 year | Sarcoma | Spindle-celled | 3 operations, recur- rence; inoperable | Inoculation of liv- ing cultures of erysipelas, 3 months, then severe attack of erysipelas by in- oculation | Well 8 years, then died of local re- currence. |

SARCOMA OF AXILLARY GLANDS

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|----------|-----|-----|------|-----------------|--------------------------------|-----------------------|---------------------|-------------------------------------|--|--|---|
| 1 F..... | 35 | M | 1911 | Axilla and neck | No | 8 months | Sarcoma | Lymphosarcoma | Two operations; X-ray; toxins | Tumors disappeared under toxin treatment | No recurrence of disease; good general condition, June, 1915. No improvement. |
| 2 B..... | 2 | M | 1902 | Axilla | No | 8 months | Sarcoma | Small round-celled sarcoma | Operation Jan., 1902 | Recurred soon; inoperable, Feb. 6, 1902; to xins short time, little effect | |
| 3 W..... | 36 | F | 1910 | Axilla | Trauma, kicked by infant | Tumor, 3 months later | Sarcoma | Small round-celled | Operation May, 1910, rapid recurrence; toxin treatment; little effect | Rapid growth | Death July 10, 1910; duration of life from beginning of disease, 5 months. Death within year. |
| 4 G..... | 50 | M | 1905 | Axilla | No | Few months | Sarcoma | Sarcoma | First operation Jan., 1904; second operation, April, 1904; local recurrence, Jan., 1905; inoperable | ..... |  |
| 5 R..... | 29 | M | 1911 | Axilla | ..... | ..... | Sarcoma | Round-celled sarcoma; lymphosarcoma | Two operations; toxins after recurrence following second operation | Entire disappearance under 4 months' treatment with mixed toxins | Well four years. |
| 6 W..... | 27 | F | 1903 | Axilla | Cut hand on vase | 3 years | Sarcoma | Round-celled sarcoma | Incomplete operation; a few injections of toxins | No effect, tumor grew rapidly | Death 3 years from time of injury. |
| 7 P..... | 47 | F | 1911 | Axilla | No | 9 months | Sarcoma | Round-celled | First operation Jan., 1911; second operation June, 1911 | Recurrence; inoperable, Sept., 1911 | |
| 8 G..... | 40 | F | 1906 | Axilla | No | Few months | Sarcoma | Lymphosarcoma | Operation March 23, 1906; adherent to axillary vein, incomplete removal; toxins for number of months | Complete recovery | Well without any return of disease Jan., 1915, 9 years later. |

| | | | | | | | | | | | |
|-----------|----|---|------------|--|-------------------|--|---------------|--|---|---|--|
| 9 F..... | 25 | M | 1913 | Axilla | ..... | Noticed only 6 weeks before operation | Lymphosarcoma | Lymphosarcoma | First operation Aug. 28, 1913; recurrence; second operation Sept. 22, 1913; recurrence; toxins begun Nov., 1913, continued large doses, partial operation Dec. 24, 1913 Operation Feb., 1912 | Grew worse rapidly | Died Feb., 1914. |
| 10 W..... | 69 | M | 1912 | Axilla | 2 years | Nearly disappeared spontaneously then, 1 year ago, began to grow again | Lymphosarcoma | Lymphosarcoma | Operation Feb., 1912 | Recurred in 4 weeks, in pectoral and axillary region; inoperable | Death within year. |
| 11 L..... | 63 | M | 1895 | Axilla | ..... | Noticed tumor a few months | Sarcoma | Round-celled | Operation Bellevue Hospital, Feb. 11, 1895; local recurrence 6 months later; Inoperable Oct. 11, 1895; toxins 10 days; patient's condition too poor to continue | No effect from few treatments | Died a few months later. |
| 12 B..... | 67 | M | Jan., 1911 | Axilla | ..... | 3 years | Sarcoma | Lymphosarcoma, endothelioma | Incomplete removal of tumor in 1911 followed by toxins | Well 2 years, then recurred; operation; toxins again; disappearance | Well Jan., 1915, 4 years. |
| 13 I..... | 57 | M | 1914 | Axilla and mediastinum | ..... | 1½ years | Sarcoma | Embryonal carcinoma | Glands removed for microscopical examination; in hospital one month | ..... | Unimproved. |
| 14 E..... | 36 | F | 1914 | Axilla | No exciting cause | 3 months | Sarcoma | (1) Perivascular hemangio-sarcoma. (2) Mixed-celled sarcoma. (3) Melanoma, Dr. Ewing | First operation April 11, 1913, followed by Coley's toxins; July 4, recurred; July 23, second operation, Coley's toxins; second recurrence Nov. 29; Jan. 5, 1914, third operation, toxins and X-ray | Recurred in few weeks; fourth operation followed by recurrence | Died in Aug., 1914 |
| 15 D..... | 33 | F | 1913 | Axilla, scapula, chest-wall and clavicle | Following a blow | 10 years | Sarcoma | Neurosarcoma | 3 operations followed by recurrence; toxins; partial operation followed by toxins; again recurrence; operation; toxins | Entire disappearance of clavicle tumor under toxins | Examination Aug. 1, 1915; no return of tumor of chest wall, but clavicle shows some enlargement. |

SARCOMA OF AXILLARY GLANDS—Continued

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|-----------|-----|-----|-------------|-----------------|--------------------------------|----------|-------------------------------|--|--------------------------------------|---|--------------------------------------|
| 16 W..... | 24 | M | Jan., 1915 | Axillary glands | Attack of influenza | 5 weeks | Sarcoma | Round-celled sarcoma or melanoma | A few doses of the toxins; no effect | Rapid progress of disease; general involvement of glands | Death within 5 weeks. |
| 17 L..... | 38 | F | Oct., 1913 | Axillary glands | ..... | 9 months | Sarcoma, or Hodgkin's disease | Malignant adenocarcinoma of lymph-node | Operation | No recurrence | Well at present, July, 1915. |
| 18 W..... | 60 | F | Sept., 1912 | Axillary glands | ..... | 1 year | Carcinoma | Typical carcinoma | Operation, followed by toxins | Remained well one year, then local recurrence; second operation, toxins; again recurrence one year later; third operation; Jan., 1915. recurrence in clavicle; later also locally | Steadily growing, worse, Dec., 1915. |

SARCOMA OF MEDIASTINAL GLANDS

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|----------|-----|-----|------------|--------------------|--------------------------------|------------|---|------------------------------|--|--|---|
| 1 B..... | 53 | M | Nov., 1908 | Mediastinal glands | ..... | 1 1/4 year | Malignant tumor, clinical and X-ray diagnosis | No microscopical examination | Toxin treatment 1 1/2 years, followed by X-ray treatment 2 years later | Slow, but steady diminution in size of tumor and improvement | Patient in good health, October, 1914; 6 years. |

INGUINAL GLAND CASES

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|--------------|-----|-----|------|-----------------|--|---|---------------------|--------------------------|--|---|---|
| 1. R..... | 18 | F | 1894 | Inguinal glands | No | 2 months | Sarcoma | Round-celled | First operation, June, 1894; recurred in 2 months; toxins 2 weeks, no benefit; second operation | Recurrence | Oct., 1894, rapid growth; death in few months. |
| 2. E..... | 61 | M | 1904 | Inguinal glands | 6 months, no trauma; treated for hernia at first | ..... | Sarcoma | Round-celled | First operation Nov., 1903; Feb. 8, 1904, inoperable recurrence | X-ray treatment, little effect | Died shortly after. |
| 3. L..... | 55 | M | 1906 | Inguinal glands | Strain 2 weeks before tumor noticed | Grew very rapidly | Sarcoma | Round-celled | Operation January, 1906; recurred in few days, other groin and axilla | March, 1906, inoperable, marked emaciation; confined to bed | Death; whole duration of disease less than six months. |
| 4. S..... | 5½ | M | 1899 | Inguinal glands | Injured groin from fall | Tumor, few days later; very rapid growth | Sarcoma | Small round-celled | Operation, Dr. W. F. Bull; incomplete removal; very rapid recurrence; toxins, 3 weeks | Improvement temporary | Died April, 1900; duration disease 11 months. |
| 5. B..... | 63 | M | 1909 | Inguinal glands | No | Several months | Sarcoma | Round-celled | First operation March, 1909; recurred July, 1909; second operation, wound infected; phlebitis; recurrence in groin and abdomen; toxins begun Dec. 6, 1909; continued to Feb., 1910 | Little effect on tumor | Died May, 1910. |
| 6. C..... | 39 | M | 1898 | Inguinal glands | Yes, blow in groin | Tumor shortly after, stationary. 4 years, then grew | Sarcoma | Round-celled | Operation Sept., 1897; recurred locally in few weeks and later in both sides of neck | ..... | Died in few months. |
| 7. L. S..... | 47 | F | 1915 | Inguinal glands | No | 2 years | Sarcoma | Lymphosarcoma | 2 operations, 1914; X-rays; toxins begun April 10, 1915 | Glands have entirely disappeared | Recurred in few months, probably in spine. Condition hopeless, Dec. 15, 1915. |

INGUINAL GLAND CASES—Continued

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|-----------|-----|-----|------|-----------------|-----------------------------------|--|---------------------|---|---|--|---|
| 8 D..... | 30 | M | 1912 | Inguinal glands | No | 3 months | Sarcoma | Lymphosarcoma (Dr. Ewing); tuberculosis (Dr. Clark). Subsequent history proved it sarcoma | Exploratory operation, tumor size of goose egg removed for examination | Decreased to one-fourth original size under toxin treatment only. Later began to increase; colloid copper tried, no effect | Emaciation and death in five months from beginning of disease. |
| 9 G..... | 45 | F | 1912 | Inguinal glands | ..... | Few weeks | Sarcoma | Round-celled | First operation, May, 1912; inoperable recurrence July, 1912; toxins, 4 months | Tumor disappeared | Jan., 1913, developed paralysis, arm and leg; no other evidence; metastasis; died Feb., 1913. |
| 10 G..... | 23 | F | 1909 | Inguinal glands | No | 1½ year, slow growth, normal labor Nov. 26, 1908 | Sarcoma | Lymphosarcoma | First operation, Aug., 1908, Dr. Asa Davis; incomplete removal | Rapid recurrence | Rapid progress. |
| 11 M..... | 23 | M | 1909 | Inguinal glands | No | 6 months. edema, leg, 2 months later | ..... | Endothelioma | Exploratory operation only; Sept. 15, 1909; toxins | Little effect | Well 1915, 4½ years. |
| 12 P..... | 7 | M | 1910 | Inguinal glands | Yes, kick in groin | Tumor, a few days later | Sarcoma | ..... | First operation Sept., 1910; tumor size of egg removed; recurrence in few weeks; toxins | Disappearance under toxins | Little effect. |
| 13 S..... | 54 | M | 1898 | Inguinal glands | No | 8 months before first operation | Sarcoma | ..... | First operation Sept., 22, 1896 | 1½ years later, local, inoperable recurrence; toxins | Well, 1915; 7 years. |
| 14 B..... | 21 | M | 1908 | Inguinal glands | Blow in groin | Tumor one week later | Sarcoma | Small round-celled sarcoma | First operation Feb., 1908; local recurrence in inguinal and iliac glands, March 26, 1908; toxins, partly by family physician | Tumors nearly disappeared; recurrence Oct. 19, 1908; disappearance under second course of toxins | Well, 1915; 7 years. |
| 15 I..... | 27 | F | 1907 | Inguinal glands | No | 4 months duration | Sarcoma | ..... | First operation June 20, 1907; Dr. Moschcowitz; referred to me for toxin after-treatment by Dr. Gerster | Toxins few weeks, little effect | Not traced. |
| 16 R..... | 48 | M | 1913 | Inguinal glands | 10 years ago infection left groin | Noticed tumor, end of July, 1913 | Sarcoma | Lymphosarcoma (Mt. Sinai Hospital) | First operation Nov. 11, 1914 | Rapid local recurrence | Not traced. |
| 17 P..... | 7 | M | 1910 | Inguinal glands | Groin kick | 3 months | Sarcoma | No microscopical examination | First operation Oct., 1910, recurred, quickly | Toxins 3 weeks; tumor broke down; curetted and drained | Well 4 years later. |

SARCOMA OF RETROPERITONEAL AND MESENTERIC GLANDS

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|-----------|-----|-----|-------------|------------------------------------|------------------------------------|--------------------------|---------------------|--|--|---|--|
| 1 W. | 25 | F | Oct., 1903 | Mesenteric glands, small intestine | No | Few months | Sarcoma, inoperable | Round-celled sarcoma, Prof. W. F. Whitney, of Harvard Medical School | Toxins, 4 months | Entire disappearance; fecal fistula developed | Recurred Jan., 1905; died, fall, 1905. |
| 2 H. | 48 | F | Feb., 1911 | Mesenteric glands | No | First noticed Jan., 1909 | Tumor | Round-celled sarcoma | 5 operations, Presbyterian Hospital, Dr. E. Eliot | Large inoperable tumor; abdomen filled when toxins tried for brief period; little effect | Death, 1911. |
| 3 P. | 45 | M | Oct., 1895 | Retroperitoneal glands | No, followed "grippe" | 1 year | Tumor, malignant | Round-celled sarcoma | Toxins 6 weeks | Inoperable; temporary decrease in size | Later grew rapidly; died Jan., 1896. |
| 4 G. | 41 | M | Nov., 1907 | Mesenteric glands, small intestine | No | 3 months | Malignant tumor | Round-celled sarcoma | Exploratory laparotomy; specimen removed | ..... | Died, few months. |
| 5 X. | 30 | F | Feb., 1907 | Mesenteric and retroperitoneal | No | 2 months | Malignant tumor | Lymphosarcoma | Exploratory operation; specimen removed | Feb. 9, 1907, abdomen filled with tumor, extreme emaciation, no treatment | Died in few weeks. |
| 6 G. | 32 | M | June, 1901 | Small intestine mesentery | Fall, April, 1901; pain soon after | 2 months | Sarcoma | Lymphosarcoma | Exploratory laparotomy; specimen removed | Rapid growth | Death, few months later. |
| 7 B. | 50 | M | Sept., 1904 | Mesentery small intestine | No | Few months | Sarcoma | Round-celled sarcoma | Exploratory laparotomy; removal of tumor; X-ray after the operation, also mixed toxins | Well 2½ years, then recurred; toxins given 3 months; slight improvement; later little effect; second operation Nov., 1907, followed by toxins; gained 12 pounds | Dec., 1907, died of shock following third operation. |
| 8 J. | 23 | F | Aug., 1894 | Mesentery and small intestine | No | Few months | Malignant tumor | Round-celled sarcoma (German Hospital, Dr. Willy Meyer) | Exploratory laparotomy; specimen removed for microscopic examination | Mixed toxins, 5 months; entire disappearance of tumor | Patient well 12 years later. |

SARCOMA OF RETROPERITONEAL AND MESENTERIC GLANDS—Continued

| Name | Age | Sex | Date | Locality | Antecedent trauma or infection | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|-----------|-----|-----|-------------|---|--------------------------------|------------|-----------------------------------|--------------------------------------|-----------------------------|--|--|
| 9 M..... | .. | F | July, 1914 | Mesenteric | No | Few months | Malignant tumor; rapid recurrence | Spindle-celled sarcoma | 2 operations in 6 months | Toxins, 1 year with intervals of rest | Well Aug. 1, 1915, more than 1 year. |
| 10 K..... | 25 | M | March, 1912 | Retroperitoneal glands, with probable involvement of iliac glands | No | 3 months | Sarcoma | Sarcoma; no evidence of tuberculosis | Inoperable; toxins 2 months | At end of 4 weeks the tumor became fluctuating and an incision was made and several ounces of fluid and broken down tumor evacuated; sinus continued | Well Nov. 1915, 3 years later; Sinus cured; Nov. 15, 1915. Diagnosis of tuberculosis in mild form, made from inoculation of guinea-pig with pus. |

HODGKIN'S DISEASE

| Name | Age | Sex | Date | Locality | Antecedent trauma or tonsillitis | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|----------|-----|-----|------------|--|----------------------------------|-----------------------------------|---------------------|---|--|---|--|
| 1 K..... | 24 | M | Oct., 1907 | Neck, axillary glands; inguinal glands, spleen and groin | No | 1 year, loss of weight, 20 pounds | Typical Hodgkin's | Hodgkin's (Dr. Ewing) | Mixed toxins | Entire disappearance in 5 weeks of all visible or palpable lesions; refused to continue treatment; recurrence in 7 months | Death 1 year later |
| 2 C..... | 29 | M | 1910 | Inguinal region; iliac fossa and liver | No | 2 years, 4 months | ..... | Blood picture not typical of Hodgkin's; nutopsy, Dr. Ewing; typical Hodgkin's | Toxins for several weeks | Only temporary improvement | Death, 1910; autopsy showed invasion of bone and muscle spine. |
| 3 E..... | 34 | M | 1909 | Neck | No | 2 years, 20 pounds loss in weight | Hodgkin's | ..... | ..... | ..... | Death. |
| 4 N..... | 25 | F | 1905, 1908 | Neck and axilla, spleen not enlarged | No | 2 years | Hodgkin's | Gland examined, typical Hodgkin's (Ewing); guinea-pig inoculations, negative | 1905, 10 X-ray and 9 toxin treatments; operation, 1908 | Temporary improvement | Not known. |
| 5 T..... | 21 | M | 1907 | Neck (1905) | No | 1 year | Hodgkin's | Glands examined, Bender laboratory; typical Hodgkin's | Toxins (Coley) | Considerable temporary improvement | Not traced. |

| | | | | | | | | | | | |
|-----------|----|---|------------|---|--|---------------------------------|--|---|---|---|-------------------------------------|
| 6 B..... | 43 | M | 1902 | Submaxillary glands; neck; later axilla, groin, spleen, liver | Trouble with molar tooth, 3 years before; tonsillitis, 1 year before | Spring, 1902, after severe cold | Typical Hodgkin's | Microscopical examination, Hodgkin's | Toxins, later X-ray; see full history | Marked temporary improvement | Died spring, 1903. |
| 7 S..... | 6 | M | 1907 | Neck, axilla, groin | No | Duration of disease, 3½ years | ..... | Typical Hodgkin's | Operation, Roosevelt Hospital, 3 years before; toxins 4 months | No effect | Death, 1908. |
| 8 R..... | 28 | M | 1907 | Neck | No | 3 years | Typical Hodgkin's | Hodgkin's, Dr. F. C. Wood | X-ray, 10 months | ..... | Not traced. |
| 9 S..... | 50 | F | 1907 | Neck, axilla, groin, spleen, liver | No | ..... | Sarcoma | Lymphatic leukemia (630,000 white cells) | Accidental erysipelas, May, 1907 | Temporary improvement | Was not traced. |
| 10 C..... | 24 | M | July, 1911 | Neck | ..... | 1 year | Lymphosarcoma | Hodgkin's disease or carcinoma | Mixed toxins, Sept., 1907; second attack erysipelas Jan., 1908 | Marked improvement | Rapid progress; died in few months. |
| 11 D..... | 47 | M | 1913 | Neck | No | 4 months | ..... | Round-celled sarcoma, first and second operations; atypical Hodgkin's after third operation (Ewing) | Portions of tumor removed for microscopical examination | Temporary improvement only | Death May, 1914. |
| 12 R..... | 25 | F | 1907 | Neck, spleen, liver, axilla, groin | No | 2 years | Clinical diagnosis and blood examination | ..... | First operation, recurrence; toxins and X-ray after second operation; third extensive operation, Jan., 1914 | ..... | Death. |
| 13 S..... | 56 | M | 1908 | Neck, liver | Following attack of tonsillitis | 8 months | Hodgkin's | Hodgkin's | Toxins, several months | Temporary decrease in size and improvement, general condition | Died few months later. |
| 14 M..... | 37 | M | 1906 | Groin | No | 3 years | Hodgkin's | Typical Hodgkin's disease; blood, 51,000 white blood cells, 4,200,000 red | Very extensive operation Aug., 1906 (Dr. Downes); tumor, size of 2 fists. Beebe's nucleoprotein serum for Hodgkin's | No effect, rapid recurrence; toxins, little effect | Died few months later. |

HODGKIN'S DISEASE—Continued

| Name | Age | Sex | Date | Locality | Antecedent, trauma or tonsillitis | Duration | Diagnosis, clinical | Diagnosis, microscopical | Treatment | Result, immediate | Result, final |
|-----------|-----|-----|---------------|----------------------------------|--|--|--|---|--|---|---|
| 15 K..... | 55 | F | 1913 | Neck | ..... | 10 years | ..... | First operation, tumor not examined; second, lymphosarcoma. Bellevue laboratory; third, typical Hodgkin's (Dr. Ewing) | 3 operations and toxins, following last operation | Marked decrease in size under toxins; later increase; again glands removed; rapid recurrence; X-ray, marked improvement | Not traced, getting worse when last seen. |
| 16 M..... | 29 | M | April, 1914 | Neck | ..... | 3½ years | Hodgkin's, one large mass on each side of neck | ..... | No treatment | ..... | Not traced. |
| 17 Z..... | 29 | M | 1914 | Tonsil and neck | Following attack of tonsillitis | Less than year | Lymphatic leukaemia, lymphosarcoma | Lymphatic leukaemia | Vaccines, X-ray; mixed toxins, streptococcus and staphylococcus | No improvement | Death within 9 months from onset of disease. |
| 18 B..... | 65 | M | June, 1913 | Neck | Cut finger 4 months previously, wound did not heal | 10 weeks | Hodgkin's disease | ..... | X-ray, 35 treatments, and vaccine treatment | Improved | Not known. |
| 19 E..... | 49 | F | March, 1915 | Submaxillary and axillary glands | ..... | 4 years | Hodgkin's disease | Pseudoleukemia, later changing into leukemia | X-ray treatment | Marked decrease in size of all tumors, but general health deteriorating | Still under treatment. |
| 20 R..... | 61 | M | Aug., 1915 | Groin | Negative | Few months | Hodgkin's—typical fever of Hodgkin's | Hodgkin's or lymphosarcoma, unable to determine which | Few X-ray treatments | Very rapid loss of flesh and strength, with extension into other glands | Died Sept., 1915; autopsy showed very extensive involvement of lymph-gland. |
| 21 P..... | 12 | M | June 11, 1915 | Axilla | No | 9 weeks, small movable tumor, right axilla | Hodgkin's | Microscopical examination showed spindle-celled sarcoma | Tumor in axilla removed 4 weeks after first noticed; quick recurrence in cervical, axillary and retroperitoneal; irregular fever | Rapid improvement under X-rays followed by rapid generalization of disease | Died Aug. 15, 1915—duration of disease, 4 months. |

TABLE OF CASES SUCCESSFULLY TREATED BY OTHER SURGEONS

While most of these patients were treated under my direction, I have thought it best to place them in a separate table. Most of these cases have been reported more fully in medical journals, the references to which are given. The histories of the other cases have been sent me by the surgeon who treated them.

CASES OF OTHER MEN, SUCCESSFULLY TREATED WITH THE MIXED TOXINS

| No. | Name of surgeon and reference | Sex | Age | Date | Locality | Type of tumor | Treatment, duration | Result, immediate | Result, final |
|-----|--|-----|-------|------------|--|---|------------------------------------|---|--|
| 1 | Dr. Herman Mynter..... Medical Record, Feb., 1905 | M | adult | 1895 | Intra-abdominal, involving caecum, omentum and mesentery | Spindle-celled | Toxins, 2 months | Entire disappearance | Patient well, 4 years later. |
| 2 | Dr. H. L. Williams..... Rochester, N. Y.; personal communication | F | .. | 1896 | Sarcoma, intra-abdominal; mesentery | Spindle-celled | 4 weeks | Entire disappearance | Patient well December, 1913; 17 years. |
| 3 | Dr. Chas. R. Barber..... Rochester, N. Y.; personal communication | M | 35 | 1894 | Intra-abdominal, very extensive, involving mesentery and omentum | No microscopical examination, but recurrent | Unfiltered toxins (Buxton) | Entire disappearance | Patient alive and well, December, 1913; 18½ years. |
| 4 | Dr. Horace Packard..... Boston, Mass.; "Five years in Surgery" and personal communication | F | 55 | May, 1896 | Inoperable, intra-abdominal, sarcoma; retroperitoneal | Spindle-celled | Toxins unfiltered | Entire disappearance | Patient well 2 years later. |
| 5 | Prof. J. Collins Warren..... Boston; Boston Medical and Surgical Journal, Dec. 26, 1896 | M | adult | 1896 | Neck, recurrent | Round-celled | Toxins unfiltered (Buxton) | Entire disappearance | Recurrence, 6 months later. |
| 6 | Dr. H. A. Matagne..... Medical, de Liege, May 14, 1896 | .. | .. | 1895 | Neck | Sarcoma (recurrent) | Toxins unfiltered, 3½ months | Entire disappearance | Slight recurrence in 6 months, not traced thereafter. |
| 7 | Ibid..... | .. | .. | 1895 | Neck, tumor size of fetal head | Sarcoma (recurrent) | Toxins unfiltered, 3 months | Decreased two-thirds | Died of shock following operation to remove the remainder. |
| 8 | Mr. W. H. Battle..... St. Thomas Hospital, London; Lancet, April 9, 1898 | M | 30 | June, 1897 | Multiple, infra-, supra-clavicular and pectoral regions and axilla | Fibrosarcoma, spindle-celled; microscopic examination by Dr. Shattock | Toxins, unfiltered, 4 months | Almost complete disappearance | Patient shown to Medical Society of London, nearly one year later. |
| 9 | Dr. F. H. Zabriskie..... Greenfield, Mass.; personal communication | F | 40 | 1896 | Intra-abdominal, recurrent; retroperitoneal | Spindle-celled | Toxins unfiltered (Buxton), 1 year | Tumor disappeared | Patient well, 12 years later. |
| 10 | Dr. John O. Roe..... Rochester, N. Y., personal communication | M | Adult | May, 1894 | Neck and tonsil, recurrent | Adenosarcoma, round-celled | Toxins unfiltered (Buxton) | Tumor improved rapidly; had almost entirely disappeared when 6 months later developed erysipelas of scalp, which proved fatal | Died of erysipelas. |

TABLE OF CASES SUCCESSFULLY TREATED BY OTHER SURGEONS—Continued

| No. | Name of surgeon and reference | Sex | Age | Date | Locality | Type of tumor | Treatment, duration | Result, immediate | Result, final |
|-----|---|-----|-------|-------------|---|---|--|--|---|
| 11 | Dr. O. C. Davies..... Augusta, Me.; personal communication | .. | Adult | April, 1901 | Neck (recurrent) | Mixed, eccelled; large, round and spindle | Mixed toxins (Buxton) | Tumor, one-half size of egg involving deep structures of neck; entire disappearance | Patient well 11 years. |
| 12 | Dr. O. W. Roberts..... Springfield, Mass.; personal communication | F | 40 | 1901 | Intra-abdominal, probably retroperitoneal; size of child's head | No microscopic examination; patient experienced much pain | Mixed toxins, several months; Parkes & Co. preparation | Entire disappearance; examined by Dr. Coley, October, 1905 | Well, Sept., 1915, 14 years. |
| 13 | Ibid..... | .. | .. | 1899 | Intra-abdominal | Sarcoma confirmed by microscopic examination | Mixed toxins, exploratory laparotomy | Entire disappearance | Well, Sept., 1915; 15 years. |
| 14 | Ibid..... | .. | .. | .... | Intra-abdominal | Sarcoma confirmed by microscopic examination | Mixed toxins, exploratory laparotomy | Entire disappearance | Well when last heard from, over 3 years later. |
| 15 | Dr. Tritch..... President North Western Medical Society, of Ohio; personal communication | M | 62 | 1912 | Inguinal and iliac glands, twice recurrent | Lymphosarcoma, round-celled | Toxins, 3-4 months | Gradual and complete disappearance | Letter from Dr. Tritch, Jan. 29, 1914, states "patient is in good health without recurrence, more than 1½ years. |
| 16 | Dr. C. E. Preston..... Ottawa, Canada; personal communication | M | 19 | June, 1903 | Typical Hodgkin's glands in neck, axilla and groin; enlarged spleen and liver | Hopeless prognosis given by staff of Ottawa General Hospital | Toxins begun June 1, 1908, and continued 6 months | Immediate local and general improvement; gain of 23 pounds in six months; palpable lesions disappeared | Patient in good health, Sept. 1, 1915, 7 years later. |
| 17 | Drs. Crile, Stanton, McMullen, and Coley Surgery, Gynecology and Obstetrics, Aug. 11, 1911 | M | 35 | Feb., 1910 | Tonsil and glands of neck | Small, round-celled sarcoma; microscopic examination by Dr. Geo. W. Crile, Dr. James Ewing and others | Tumor pronounced inoperable by Dr. Crile; toxins administered by Dr. W. | Almost complete disappearance in 5 weeks; injections cut down to 5 a month, end of 5 weeks tonsils again enlarged to twice normal size; microscopic examination, R. C. sarcoma; 15 injections of toxins in September | Entire disappearance of tumor; doses again cut down; recurrence; toxins showed less and less effect; rapid growth; death; Feb. 7, 1912 complete autopsies, no metastases. |
| 18 | Dr. F. B. Benham..... Syracuse, N. Y.; personal communication | F | Adult | 1911 | Intra-abdominal, involving mesentery and intestines | Sarcoma, inoperable (microscopic examination) | Exploratory laparotomy; case regarded as hopeless; toxins several months | Entire disappearance | Well 1½ years later. |

| | | | | | | | | | |
|----|--|----|-------|---------------|---|---|---|--|--|
| 19 | Major C. G. Spencer..... Royal Army Medical Corps, London Lancet, Dec. 21, 1912; personal communication | M | 25 | July, 1912 | Neck | Lymphosarcoma, amination (round-celled) | First operation March 6, 1912; rapid recur- rence; second opera- tion March 29, 1912, whole left side of neck filled with enlarged glands | Incomplete opera- tion, March 29, 1912; rapid re- currence; toxins begun April 6, 1912 (Parke- Davis prepara- tion), doses daily beginning M. ½ -M. 10; all in- jections local | 2 months' treat- ment; entire dis- appearance in 6 weeks; treatment one month longer M. 10 alternate days, total 150 minims; perfect health 1 year later. |
| 20 | Dr. David S. Runnels..... Appleton, Wis.; personal com- munication | M | 39 | Feb., 1911 | Intra-abdominal, right side; mesentery | Sarcoma (clinical diagnosis) | Exploratory laparot- omy; tumor 6 inches in diameter; inoper- able; no microscopic examination; toxins begun March, 1911 | Doses M. ¼ to M. xv made mostly into tumor; slow but steady im- provement; toxins kept up nearly 2 years | Entire disappear- ance of tumor; gain of 45 pounds; in weight; pa- tient in good health Oct., 1913 —2½ years. |
| 21 | Dr. Geo. H. Muller..... Philadelphia University, Pa. Hospital; Transactions Phila- delphia Medical Society, ANNALS OF SURGERY, Feb., 1910 | M | .. | 1907 | Neck; recurrent in one month; inoperable | Lymphosarcoma, microscopic ex- amination by pathologist of University Hos- pital | Toxins, no other treatment | Complete recov- ery | Patient well 4 years later, 1 month thereafter suddenly showed local recurrence and intra- abdominal me- tastases. |
| 22 | Dr. Arthur D. White..... Ithaca, N. Y.; personal com- munication | F | Adult | Dec., 1912 | Ovary, with involvement of mesentery and intes- tines | Adenocarcinoma, microscopic ex- amination, Dr. James Ewing | Incomplete removal by Dr. Robert T. Morris, early Dec., 1912; quick recur- rence, rapid growth; general condition, poor; toxins begun Dec. 30, 1912; ad- vised because origi- nal diagnosis was sarcoma | Immediate im- provement which continued until complete disappearance by April, 1913 | Patient well Dec., 1913, 1 year later, no recur- rence. |
| 23 | Dr. M. E. Green..... American Journal of Homcop- athy, Dec., 1907; personal communication | M | Adult | 1907 | Neck, lymphosarcoma; 4 times recurrent | Round-celled | Toxins, several months | Entire disappear- ance | Patient well over 3 years. |
| 24 | Dr. M. E. Green..... American Journal of Homcop- athy, Dec., 1907; personal communication | M | Adult | 1907 | Neck, lymphosarcoma; 4 times recurrent | Round-celled | Toxins, several months | Entire disappear- ance | Patient well over 3 years. |
| 25 | Dr. J. D. Griffith..... Kansas City; personal communi- cation | .. | .. | .... | Neck, inoperable | Sarcoma, micro- scopic examina- tion | Toxins | Recovery | Well over 3 years. |
| 26 | Ibid..... | .. | .. | .... | Neck, inoperable | Sarcoma, micro- scopic examina- tion | Toxins | Recovery | Well over 3 years. |

TABLE OF CASES SUCCESSFULLY TREATED BY OTHER SURGEONS—Continued

| No. | Name of surgeon and reference | Sex | Age | Date | Locality | Type of tumor | Treatment, duration | Result, immediate | Result, final |
|-----|--|-----|-------|------|----------------------------------|--|--|---|---|
| 27 | Ibid..... | .. | .. | .... | Neck, inoperable | Sarcoma, microscopic examination | Toxins | Recovery | Well over 3 years. |
| 28 | Ibid..... | .. | .. | .... | Neck | Sarcoma, microscopic examination | Toxins | Recovery | Well over 3 years. |
| 29 | Dr. W. L. Rodman..... Prof. Surgery, Medico-Chirurgical College, Philadelphia; personal communication | M | Adult | 1897 | Tonsil and pharynx | Sarcoma, microscopic examination; recurrent after 4 months | Entire disappearance under toxin treatment | Complete recovery | Patient well 16 years later. |
| 30 | Dr. J. H. Glass..... Utica, N. Y.; personal communication | M | 19 | 1905 | Neck | Small, rounded sarcoma (recurrent) | 2 operations; toxins one year | No recurrence, entire disappearance | Patient in good health 8 years after. |
| 31 | Dr. Cruikshank, Alex..... Salem, Ohio; personal communication | M | Adult | 1913 | Retroperitoneal glands | Sarcoma, no microscopic examination | Exploratory operation, colostomy; mixed toxins 4 months | Decrease in size of tumor; patient gained in weight | entire disappearance, perfect condition 1½ years later. |
| 32 | Dr. Jos. Grindon..... St. Louis, Mo. | F | 50 | 1897 | Neck, recurrent in thoracic wall | Spindle-celled sarcoma | Operation, incomplete; prompt recurrence; toxins after recurrence | Disappearance under 5 months' treatment with the toxins, Feb. 1898, recurrence in thoracic wall; operation followed by toxins | Patient then remained free from recurrence until death, eight years later, due to an acute pulmonary condition. |
| 33 | Dr. Percy Shields..... Cincinnati, Ohio | F | 48 | 1913 | Tonsil and neck | Myxosarcoma | Toxin treatment from Sept. 28, 1913, to Dec. 31, 1914 | Complete disappearance under 3 months' treatment | Patient well at present, nearly 2 years later. |
| 34 | Dr. Reginald Fitz..... New York City (?) | M | 5 | .... | Neck | Non-malignant (Dr. Ewing) | Toxins | Tumor continued to increase in size | Death 3 months later. |
| 35 | Dr. A. Jacoby..... New Orleans, La. | M | 58 | 1912 | Inguinal glands | Small, rounded sarcoma | Incomplete operation by Dr. F. W. Parham, New Orleans, La.; toxins by Dr. Jacoby, under my direction | Began to improve, entirely well July 13, 1912 | Patient still well, June, 1915; 3 years. |
| 36 | Dr. J. H. Glass..... Utica, N. Y. | F | 19 | 1905 | Neck | Small, rounded sarcoma | First operation by Dr. Marshall, Feb. 28, 1906; March 13, 1906, operation by Dr. J. H. Glass, Utica, N. Y., followed by toxins | ..... | Patient in good health when last heard from, Feb. 11, 1914; 8 years later. |

CONCERNING THE SURGICAL ANATOMY OF THE THYROID WITH SPECIAL REFERENCE TO THE PARATHYROID GLANDS*

BY EUGENE H. POOL, M.D.
OF NEW YORK

ATTENDING SURGEON TO THE NEW YORK HOSPITAL; CONSULTING SURGEON TO THE FRENCH HOSPITAL
NEW YORK

AND

HENRY C. FALK, M.D.

CERTAIN steps in the operative procedures which are employed as routine in the surgery of the thyroid gland may be attended by confusion if the operator lacks an exact knowledge of the anatomy of the parts involved. Thus, in connection with the operation of excision of a lateral lobe, considerable uncertainty prevails as to the relationship of the surgical capsule, the parathyroid glands and the recurrent laryngeal nerve to the posterior part of the lobe. The consideration of these essential anatomical details, as they bear upon the operation of lobectomy, is the basis of this paper.

Excision of Lobe.—The removal of a lateral lobe of the thyroid gland is frequently indicated in the surgical treatment of simple goitre and exophthalmic goitre. The extirpation of the lobe as usually practised is intracapsular, that is, the lobe is shelled out of the surgical capsule, which is a connective-tissue envelope formed from the deep cervical fascia (Fig. 1). All surgeons recognize the importance of careful dissection at the posterior aspect of the lobe in order to avoid injury to the recurrent laryngeal nerve and to safeguard the parathyroid glandules. Yet there is divergence of opinion and of practice as to whether the extirpation should include the posterior part of the lobe or whether a layer of thyroid tissue should be left in this region (Fig. 2). The latter procedure offers a greater degree of protection to the inferior laryngeal nerve and to the parathyroid glands; but it results in more hemorrhage, which in some cases is difficult to control; moreover, it prolongs the operation and leads to greater post-operative exudate.

The present study was undertaken primarily to determine whether the theoretical advantages of leaving a portion of the posterior part of the lobe, that is, the part in relation with the recurrent laryngeal nerve and the parathyroid bodies, have sufficient anatomical basis to outweigh the practical disadvantages of the procedure. With this object in view,

* Read before the New York Surgical Society, October 27, 1915, and the Chicago Surgical Society, November 5, 1915.

an effort has been made to trace the course and to establish the relations of the surgical capsule in the posterior region of the lobe and to determine the relationship of the parathyroids and the recurrent laryngeal nerve to this fascia and to the thyroid itself.

Surgical Capsule.—Transverse sections of the neck were made from three cadavers. The drawing (Fig. 3), which may be considered typical, shows the general arrangement of the fascial planes.

Several features in the gross sections are worthy of note. First, the surgical capsule in the non-goitrous neck is not as well marked as might be expected from the conditions noted in operations upon goitrous glands. However, it is fair to assume that the difference in the fascial planes around a normal and a goitrous thyroid is merely one of degree. In other words, although the surgical capsule may be thicker and better marked around a goitrous than a normal thyroid the structural details and arrangement are essentially the same. Second, the sheath of the great vessels is closely associated with the surgical capsule of the thyroid. This feature is corroborated by microscopic sections (Figs. 4 and 5). *Third, the surgical capsule at the posterior aspect of the lobe divides into two layers*, one, relatively dense, passes posterior to the œsophagus to enter into the formation of the prevertebral fascia; the other passes forward and mesially to the postero-external aspect of the trachea. *This layer is of especial importance, since it constitutes the surgical capsule in this region.* It consists of a thin dense layer closely apposed to the thyroid (Figs. 6, 7 and 8).

The separation of the surgical capsule into two layers, as just described, is of considerable importance. In the normal (non-goitrous) neck this separation defines a triangular area bounded by these two fascial layers and, mesially, by the œsophagus. This space contains loose areolar tissue and in it lies the *recurrent laryngeal nerve* (Figs. 3 and 6). When the thyroid enlarges the space may be obliterated, in which case the two layers lie in apposition. Certain anatomical details which bear directly upon the operation of lobectomy are thus made clear. They may be summarized as follows: There is a continuation of the surgical capsule in the posterior region of the lobe; outside of this fascial layer lies the recurrent nerve which is consequently safeguarded in a true intracapsular extirpation of a lobe. However, it is evident that in the performance of an intracapsular extirpation, or lobectomy, the capsule is likely to be torn in the region of its division into the two layers; the operator then follows the posterior layer in the dissection and the cellular plane between the two layers is entered and the recurrent laryngeal nerve is endangered.

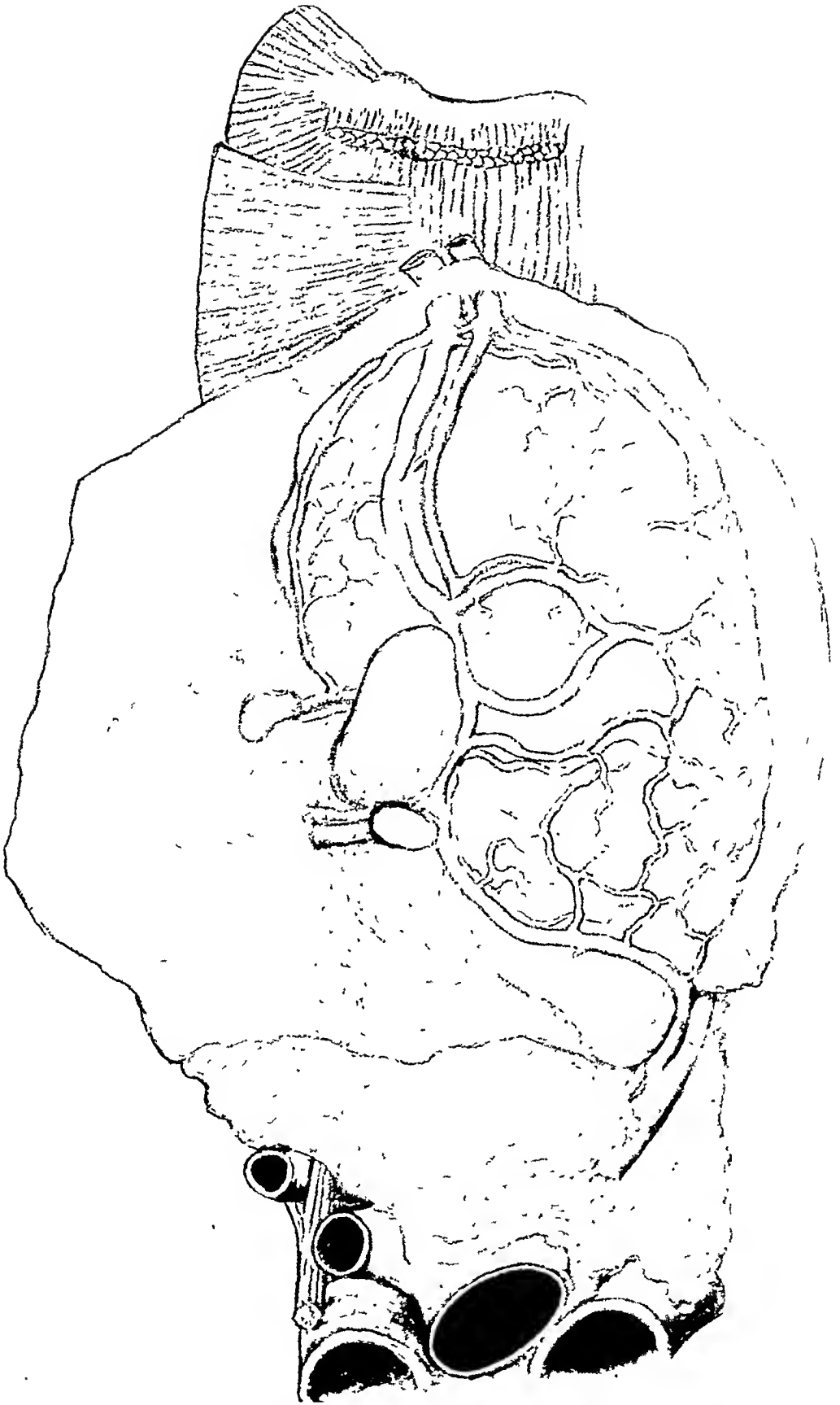


FIG. 1.—Autopsy specimen from patient with exophthalmic goitre, showing the capsule cut and stripped from the right lobe, the lobe being drawn forward so as to expose the structures in relation with its posterior surface. The relations of the parathyroids to the inferior thyroid artery and capsule are of particular interest in this specimen. The superior parathyroid stripped off readily with the capsule, the inferior did not strip off and was left in close contact with the thyroid and the lower branch of the inferior thyroid artery.

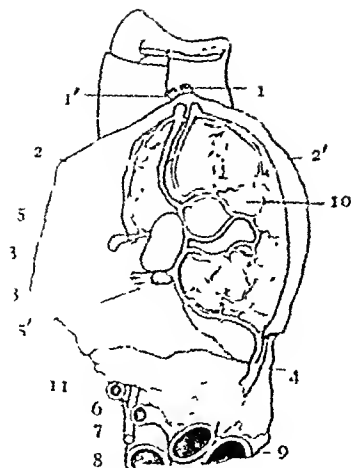


FIG. 1.—1, superior thyroid artery; 1', superior thyroid vein; 2, 2', surgical capsule stripped from the gland; 3, branches of inferior thyroid artery with accompanying veins; 4, inferior thyroid veins; 5, superior parathyroid; 5', inferior parathyroid; 6, recurrent laryngeal nerve; 7, vagus nerve; 8, trachea; 9, aorta; 10, thyroid; 11, subclavian artery.

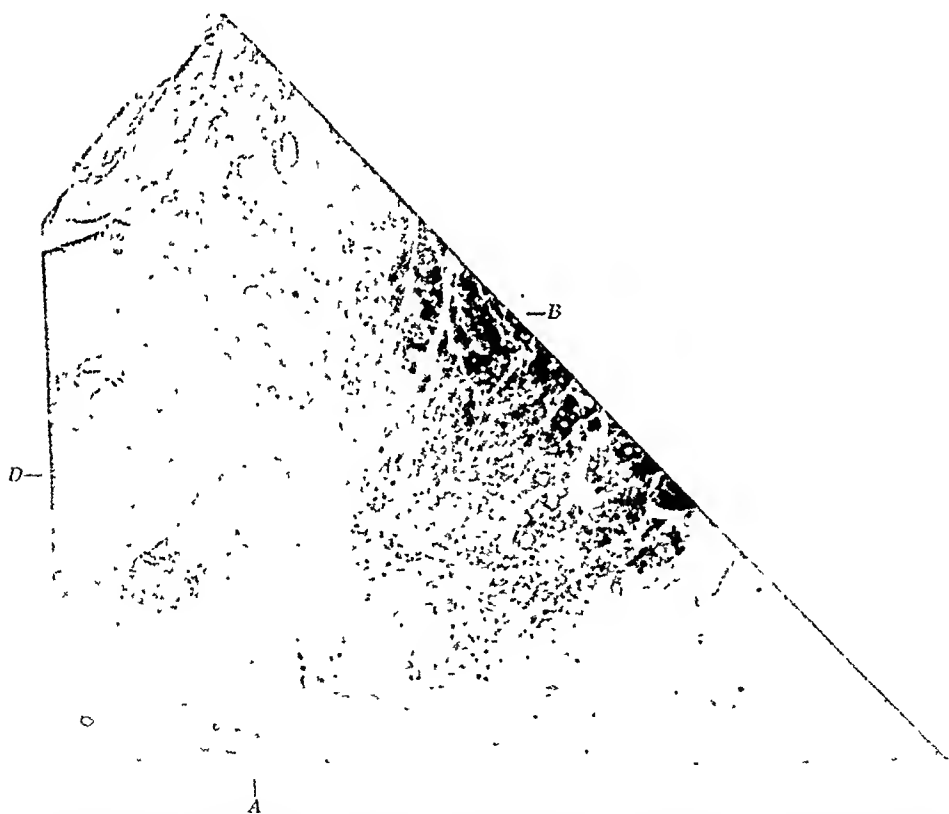


FIG. 2.—Approximate line of division when posterior part of lobe is left so as to safeguard the parathyroids and recurrent laryngeal nerve, of which four filaments may be seen between thyroid and oesophagus. A, parathyroid; B, thyroid; D, oesophagus (magnification, $\times 15$).

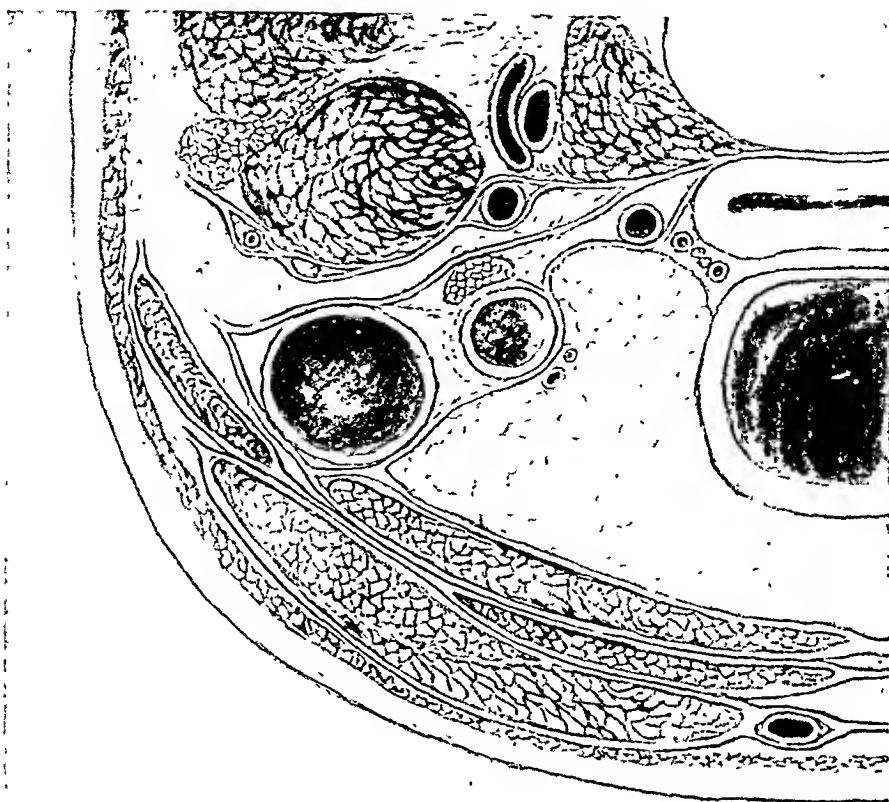


FIG. 3.—Transverse section of the neck at level of the middle of the seventh cervical vertebra showing general arrangement of the fascial planes.

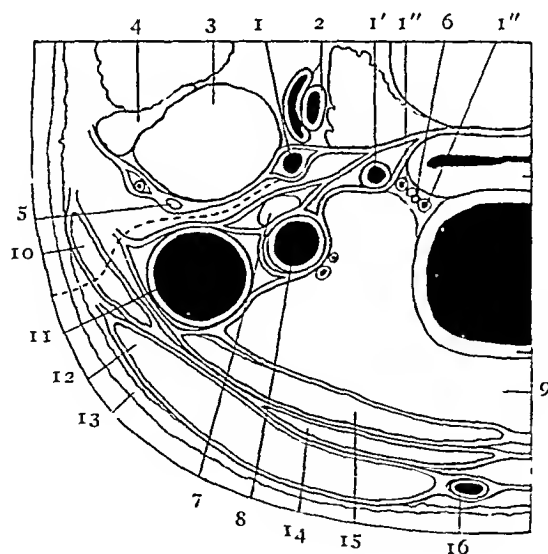


FIG. 3a.—Outline of Fig. 3. 1, 1', 1'', inferior thyroid artery; 2, vertebral artery and vein; 3, scalenus anticus; 4, brachial plexus; 5, phrenic nerve; 6, recurrent laryngeal nerve; 7, vagus; 8, carotid artery; 9, thyroid; 10, omohyoid; 11, jugular vein; 12, sternomastoid; 13, platysma; 14, sternohyoid; 15, sternothyroid; 16, anterior jugular vein. Dotted line indicates approach for ligation of inferior thyroid artery by posterior method. (The operative approach is above the omohyoid, 10.)

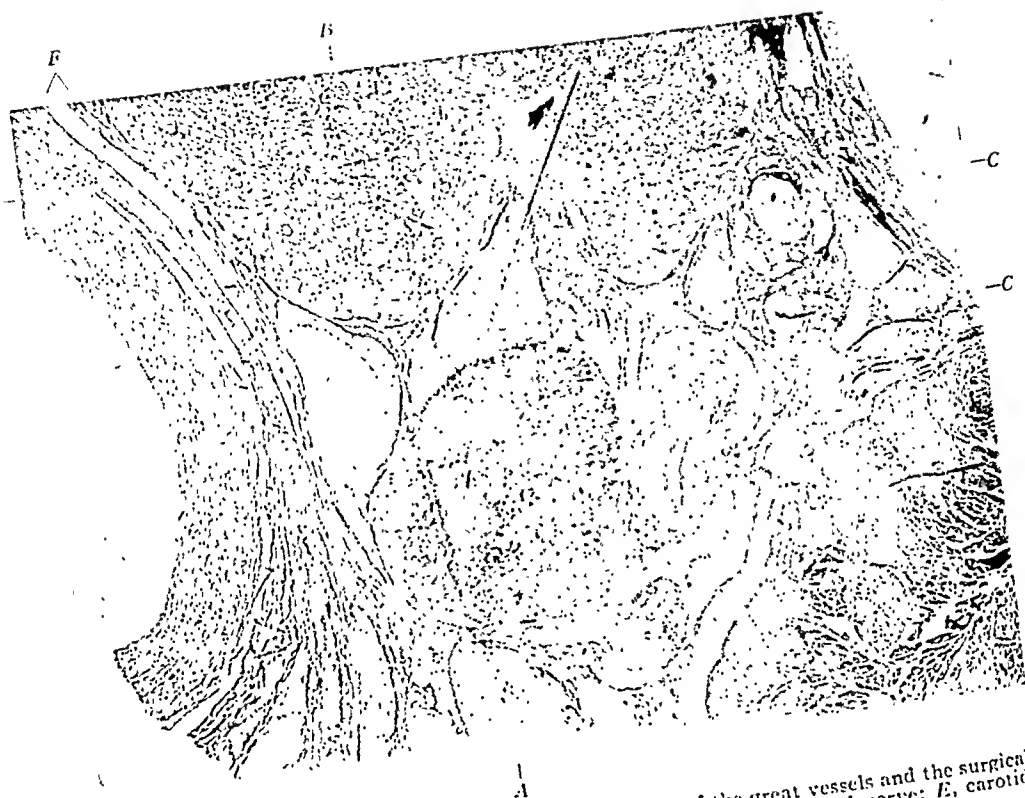


FIG. 4.—Showing close relationship between the sheath of the great vessels and the surgical capsule of the thyroid. *A*, parathyroid; *B*, thyroid; *C*, recurrent laryngeal nerve; *E*, carotid; *F*, surgical capsule and carotid sheath.

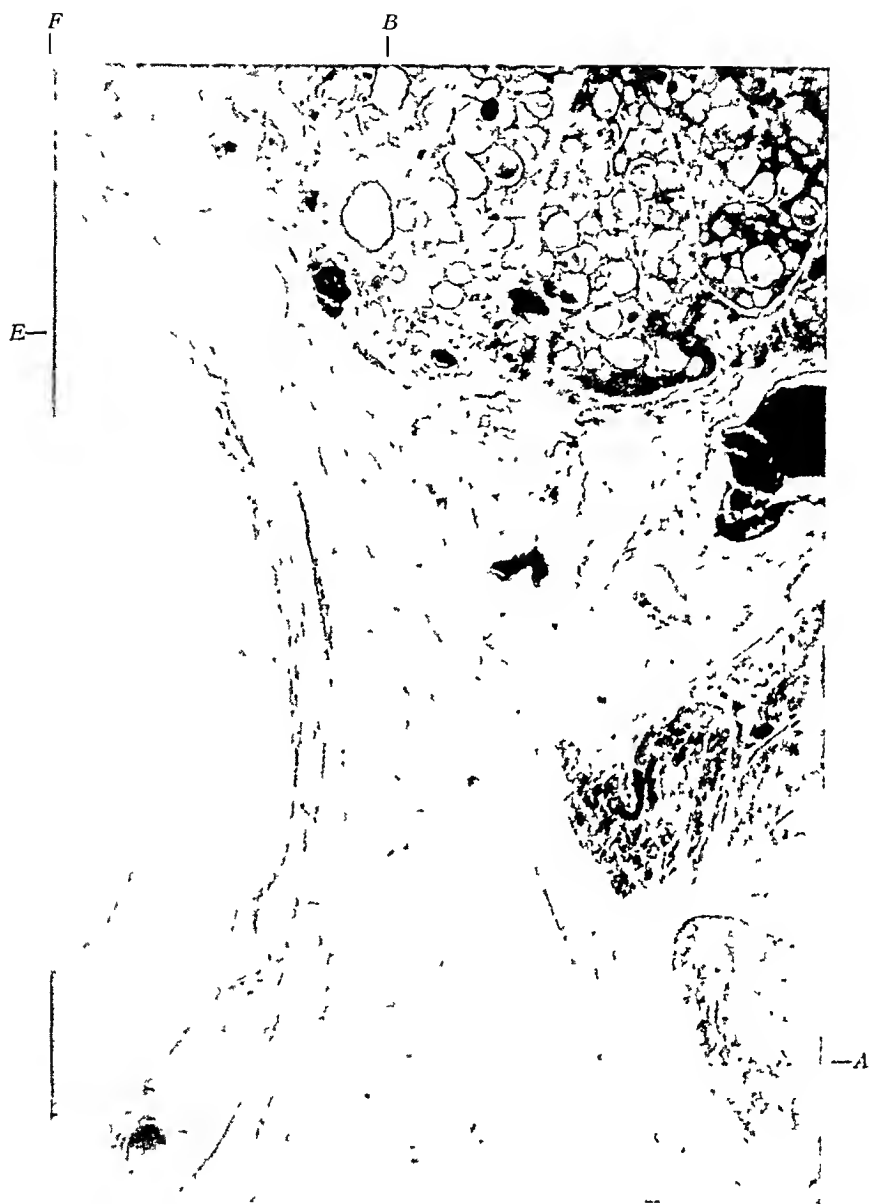


FIG. 5.—Showing close relationship between sheath of the great vessels and the surgical capsule of the thyroid .A, parathyroid, B, thyroid, E, carotid, F, surgical capsule and carotid sheath.

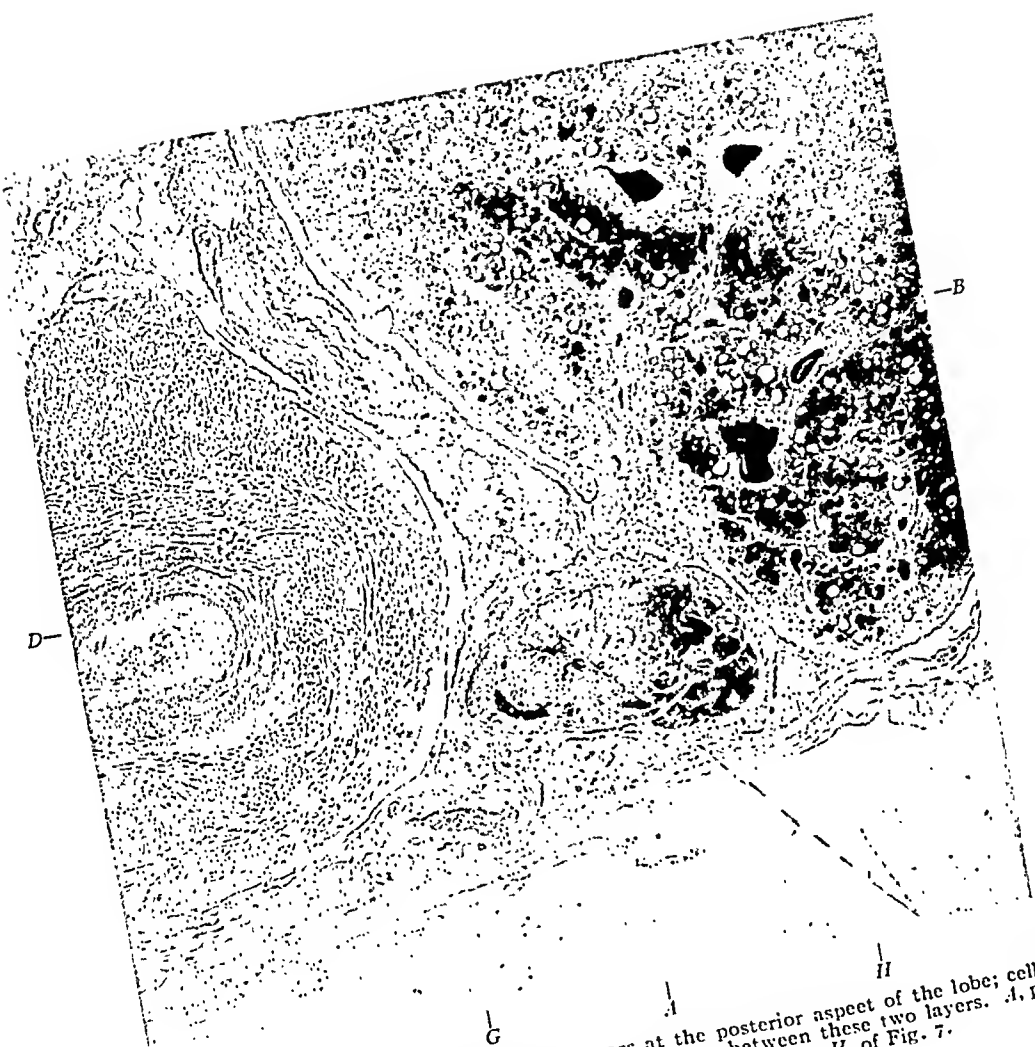


FIG. 6.—Division of the capsule into two layers at the posterior aspect of the lobe; cellular space, containing parathyroid and recurrent laryngeal nerve between these two layers. *A*, parathyroid; *B*, thyroid; *D*, cesophagus; *G*, high power of this area, Fig. 8; *H*, of Fig. 7.

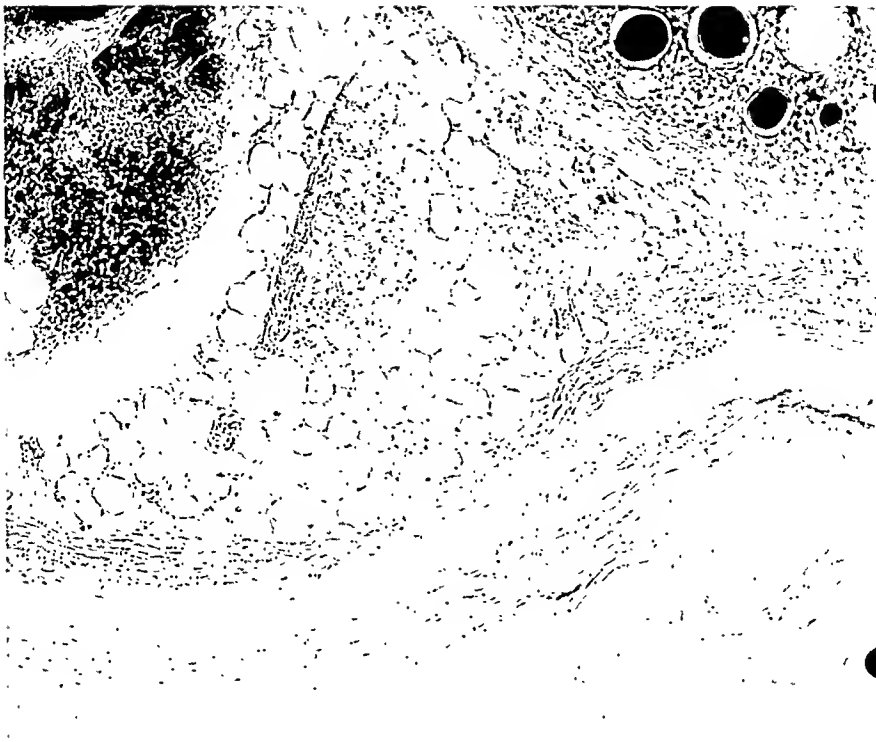


FIG. 7.—High power of Fig. 6, showing division of surgical capsule into two layers (magnification $\times 120$).

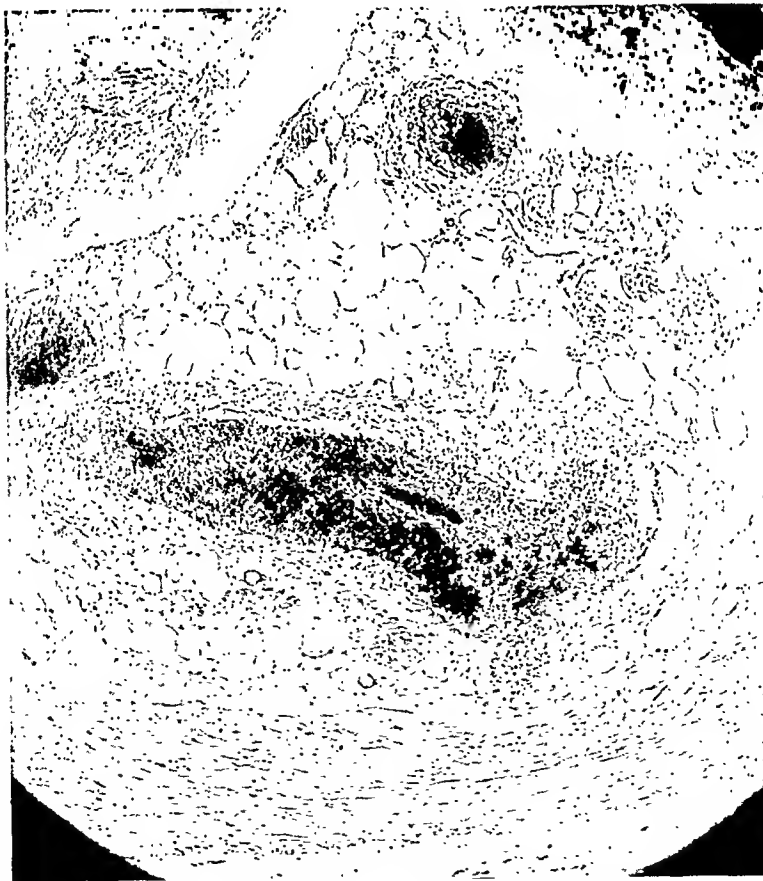


FIG. 8.—High power of Fig. 6, showing dense layer of connective tissue which passes posterior to œsophagus (magnification. $\times 120$).



FIG 9.—Parathyroid external to the capsule and at such a distance from the thyroid as to be safeguarded by an intracapsular operation. The nerve and branch of inferior thyroid artery lie between the parathyroid and the thyroid (Class I). A, parathyroid; B, thyroid; C, nerve.

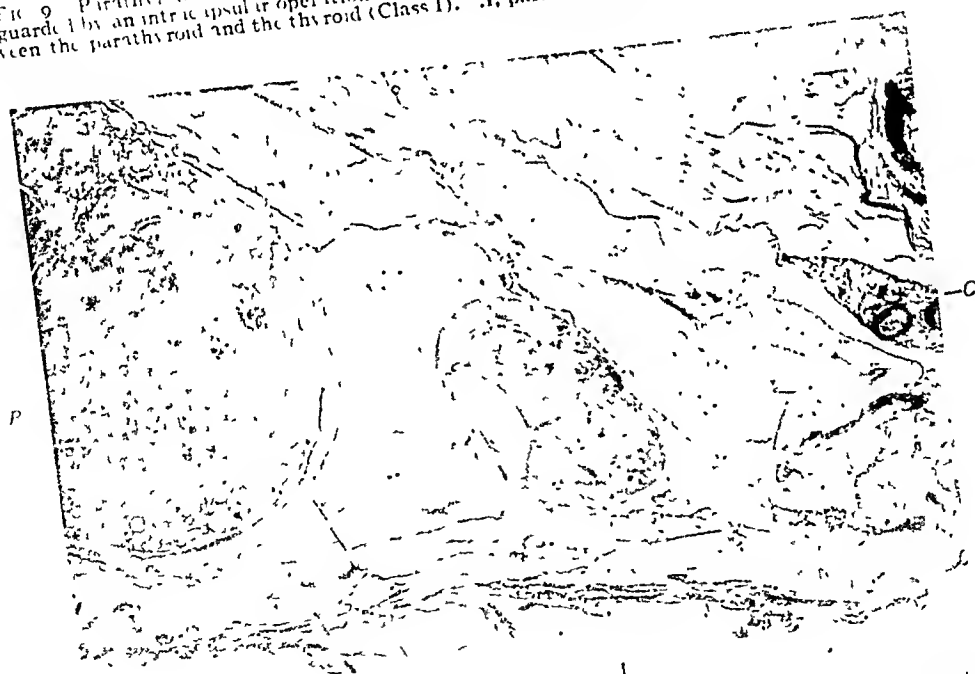


FIG 10.—Parathyroid external to the capsule and at such a distance from the thyroid as to be safeguarded by an intracapsular operation. The parathyroid lies between the nerve and the thyroid (Class I). A, parathyroid; B, thyroid; C, recurrent laryngeal nerve.

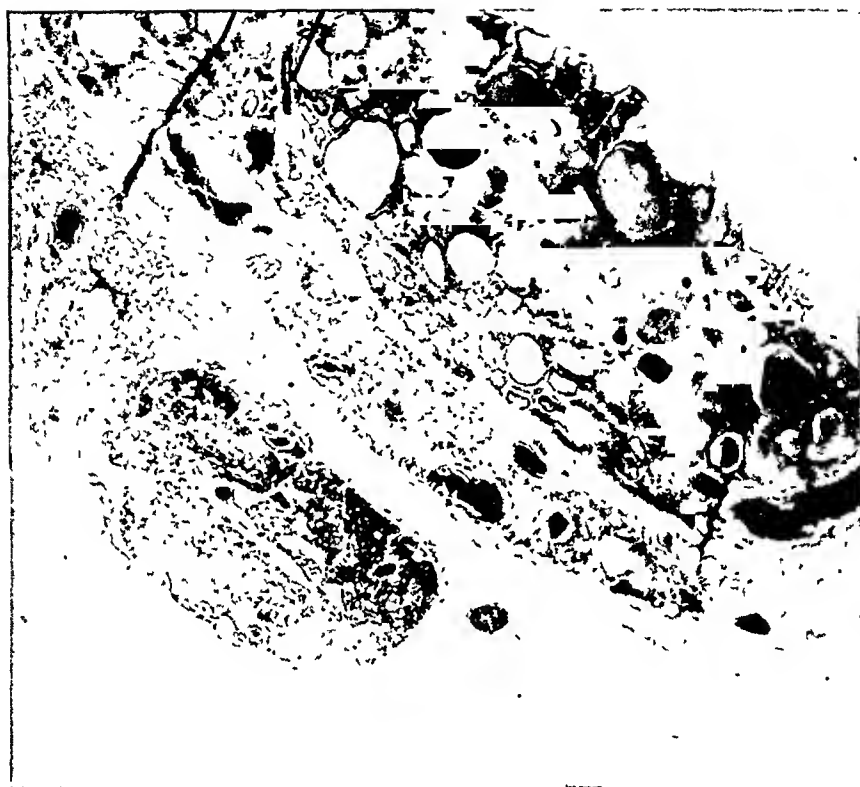


FIG. 11.—Parathyroid separated from thyroid by dense capsule.



FIG 12.—Parathyroid so close to thyroid that it might be endangered in an "intracapsular" removal of lobe (Class II).

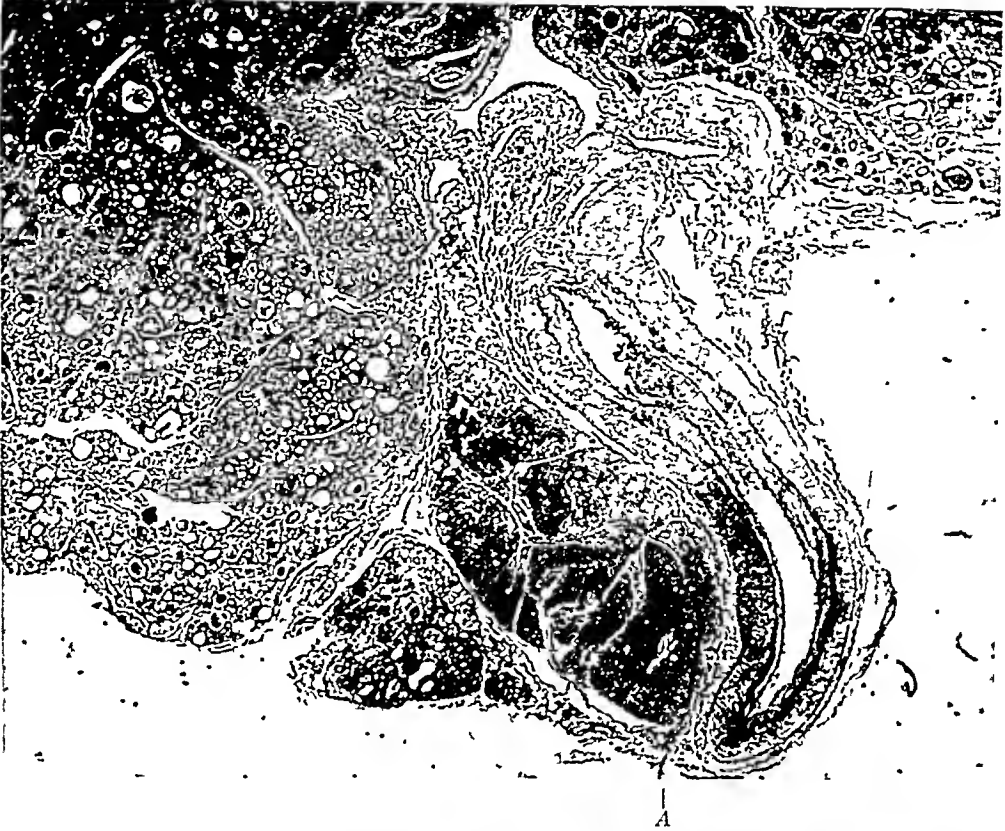


FIG. 13.—Parathyroid so close to thyroid that it would be endangered in an "intracapsular" removal of the lobe (Class II). A, parathyroid.



FIG. 14 —Parathyroid in such close relation to the thyroid that it would probably be removed with the lobe in an intracapsular lobectomy (Class III).



FIG. 15.—Parathyroid in such close relation to the thyroid that it would probably be removed with the lobe in an "intracapsular" lobectomy (Class III). A, parathyroid; B, thyroid; D, esophagus.

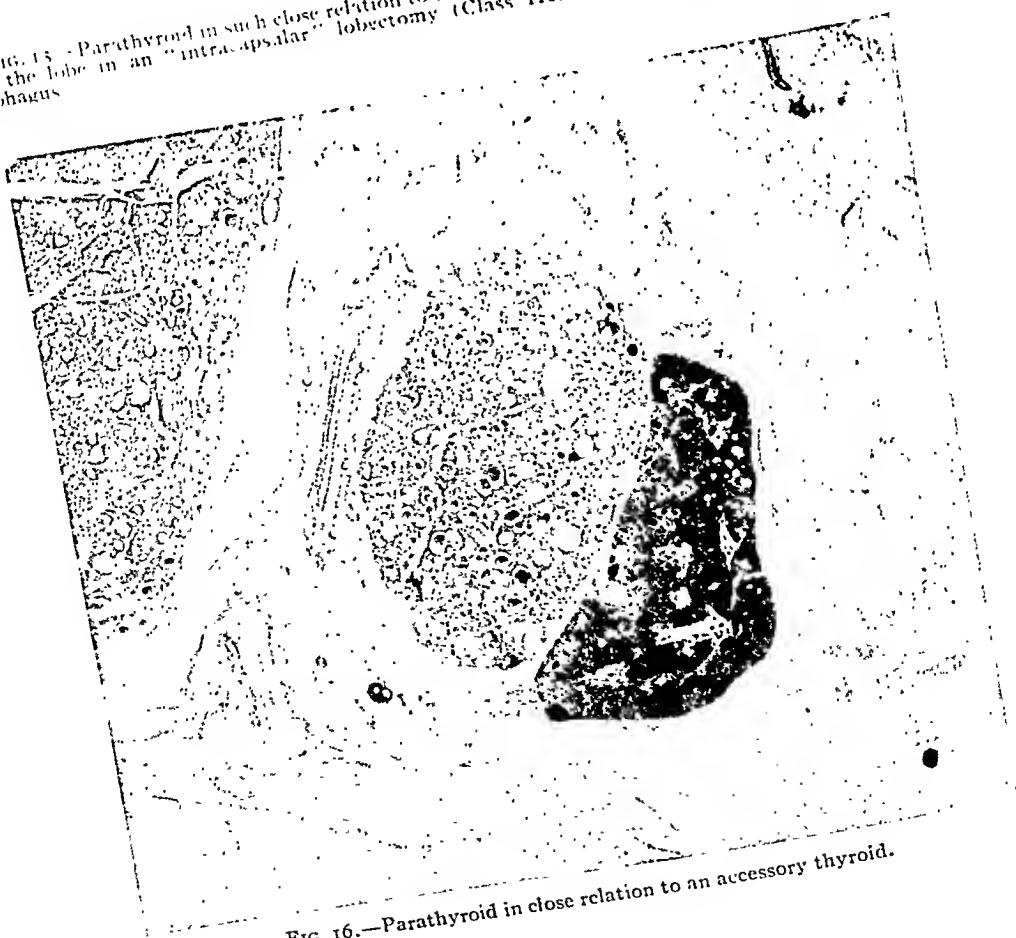


FIG. 16.—Parathyroid in close relation to an accessory thyroid.

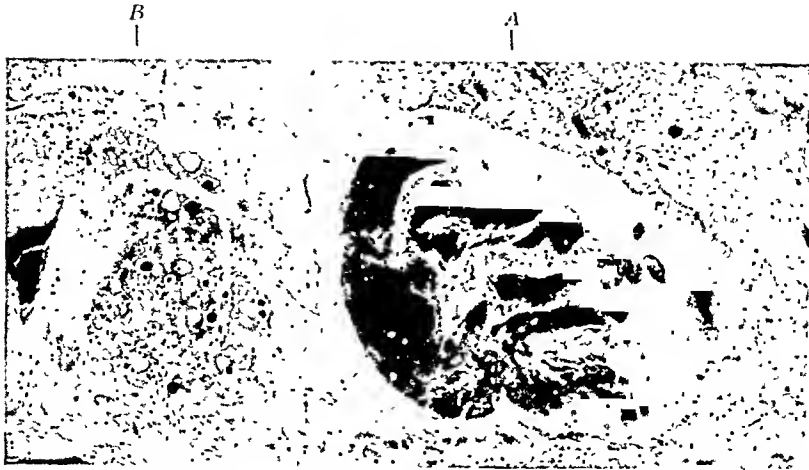


FIG. 17.—Parathyroid situated at and below the extreme lower pole of the thyroid lobe. *A*, parathyroid; *B*, thyroid.



FIG. 18.—To contrast different relationships of thyroid, parathyroid, recurrent laryngeal nerve, inferior thyroid artery and œsophagus. Compare Fig. 19.



FIG. 19.—To contrast different relationships of the thyroid, parathyroid, recurrent laryngeal nerve, inferior thyroid artery and œsophagus. Compare with Fig. 18. A, parathyroid; B, thyroid; C, nerve; D, œsophagus.

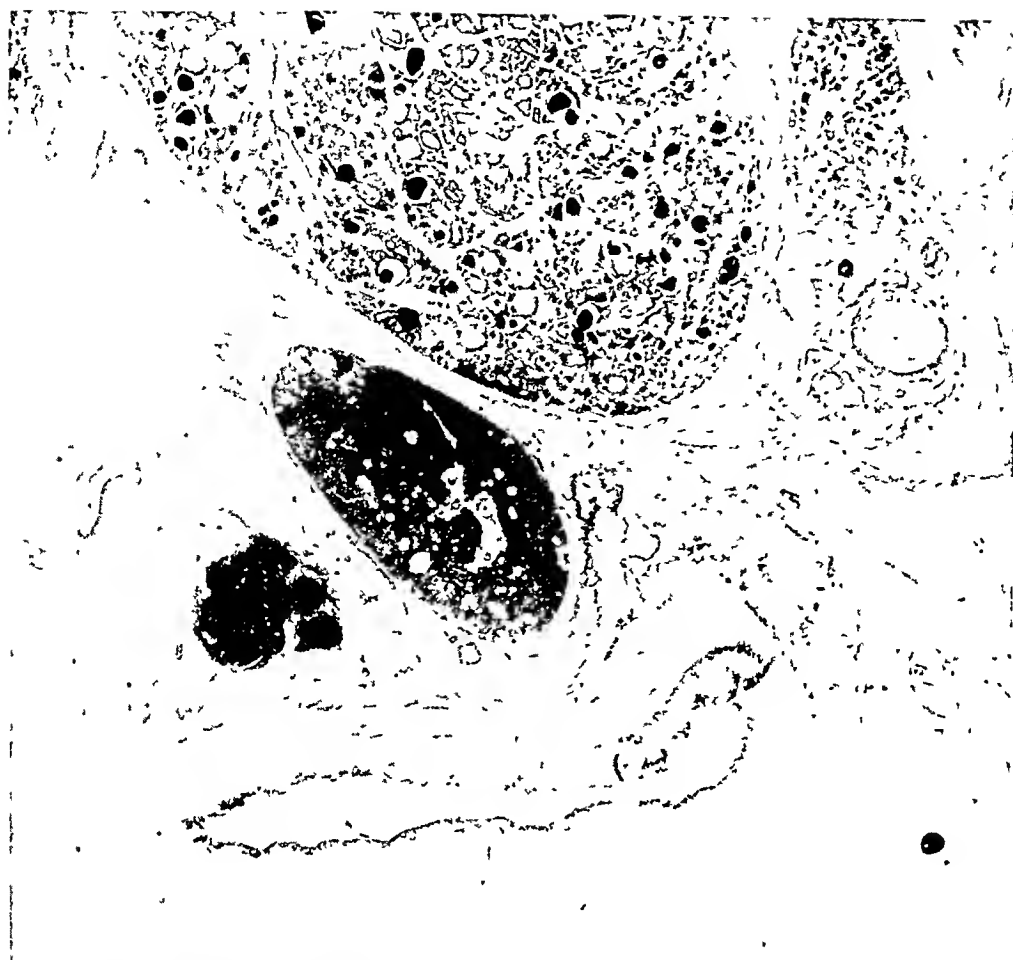


FIG. 20.—Parathyroid lying between branch of inferior thyroid artery and thyroid gland; separated from the latter by a dense layer of fascia.



FIG. 21.—Showing parathyroid flattened out on side of thyroid.

THE PARATHYROID GLANDS

The Topography of the Parathyroids.—The tissues of the neck anterior to the spine were removed at autopsy in 25 cases. They were cut transversely in thin layers and a search was made for the parathyroid glands. When tissue suggestive of a parathyroid was found it was blocked with the surrounding structures and sections were made for microscopic examination.

Sixty parathyroids were found and studied. They may be grouped as follows:

Class I. Those which lay external to the capsule at sufficient distance from the thyroid and in such a position as to be safeguarded in an intracapsular extirpation of the lobe. These numbered 26, or 43.3 per cent. (Figs. 9, 10 and 11).

Class II. Those whose relationship to the capsule and to the thyroid was such as to make it doubtful whether they would be saved in an intracapsular removal of the lobe. These were 9 in number, or 15 per cent. (Figs. 12 and 13).

Class III. Those whose position was such that they would almost certainly have been removed with the thyroid in an intracapsular extirpation of the lobe. These numbered 25, or 41.7 per cent. (Figs. 14 and 15).

Summary.—25 specimens sectioned for parathyroids; 60 parathyroids found:

TABLE I

| | |
|-----------------------------------|----------|
| 0 parathyroid | 2 cases |
| 1 parathyroid | 2 cases |
| 2 parathyroids | 10 cases |
| 3 parathyroids | 6 cases |
| 4 parathyroids | 5 cases |
| Right superior | 12 |
| Left superior | 14 |
| Right inferior | 16 |
| Left inferior | 16 |
| Right middle ¹ | 1 |
| Not classified ² | 1 |

The occurrence of the parathyroid glands in pairs may properly be considered the typical arrangement, a superior and inferior body being present on each side. *Although variations in the anatomical positions are frequent*, it may be stated that the superior most often lies in relation to the middle third of the posterior border of the lateral lobe of the thyroid; the inferior in relation to the inferior third of the posterior

¹ Only three were found; all on one side.

² Only one was found in the first case studied; its situation was not recorded.

surface of the lobe or lower, even below the inferior pole. Accessory accumulations of characteristic parathyroid cells may be present, especially below the thyroid and within the thyroid (Getzowa). Such aberrant parathyroids probably prevent, in some cases, ill effects from the sacrifice of considerable parathyroid tissue.

In Table II the situation of each parathyroid relative to the surgical capsule is represented as follows:

Class I. Those which lay external to the surgical capsule in such a position as to be safeguarded in an intracapsular extirpation of the lobe ("I" in table).

Class II. Those whose relationship to the surgical capsule and to the thyroid make it doubtful whether they would have been saved ("II" in table).

Class III. Those whose relationship was such that they would almost certainly have been removed ("III" in table).

TABLE II

| No. of specimen | Left superior | Left inferior | Right superior | Right inferior | Not classified |
|-----------------|-----------------------|---------------|------------------|----------------|------------------|
| 1..... | | | | | III ² |
| 2..... | ..... | I | I | III | |
| 3..... | I | II | ..... | I | |
| 4..... | ..... | III | ..... | III | |
| 5..... | II | I | I | I | |
| 6..... | I | ..... | III | I | |
| 7..... | III | III | III | III | |
| 8..... | No parathyroids found |  |  | ..... |  |
| 9..... | ..... | ..... | I I ¹ | I | |
| 10..... | No parathyroids found |  |  | ..... |  |
| 11..... | III | I | III | I | |
| 12..... | III | ..... | III | ..... |  |
| 13..... | II | III | III | III | |
| 14..... | II | III | III | II | |
| 15..... | ..... | I | ..... | ..... |  |
| 16..... | I | I | ..... | ..... |  |
| 17..... | ..... | II | ..... | II | |
| 18..... | I | ..... | III | ..... |  |
| 19..... | III | III | III | ..... |  |
| 20..... | II | ..... | ..... | III | |
| 21..... | ..... | II | ..... | I | |
| 22..... | ..... | III | ..... | I | |
| 23..... | I | ..... | ..... | III | |
| 24..... | ..... | I | ..... | I | |
| 25..... | I | I | I | ..... |  |

Summary of Table II.—In a unilateral intracapsular removal of a lobe:

Left lobe: Two parathyroids would have been sacrificed (Class III) 2 times, or 8 per cent.; two parathyroids likely to be sacrificed (Class II) 2 times, or 8 per cent.

THE PARATHYROID GLANDS

Right lobe: Two parathyroids would have been sacrificed (Class III) 2 times, or 8 per cent.; two parathyroids likely to be sacrificed (Class II) once, or 4 per cent.

To estimate the risk to the individual, the percentage based upon the 50 lobes in the 25 cases must be divided by two; therefore, on the basis of these figures, the operation of unilateral intracapsular lobectomy is attended with a risk of 8 per cent. that two parathyroids will be removed; this would be increased to 14 per cent. if the doubtful cases were included.

In bilateral intracapsular removal of both lobes: 4 parathyroids would have been sacrificed (III) in one case, 4 per cent.; 4 parathyroids likely to be sacrificed (II) in two cases, 8 per cent.; endangered in 12 per cent.

TABLE III

| | Apparently safe (not removed) (Class I) | Doubtful (Class II) | Probably removed (Class III) |
|-----------------------------------|---|------------------------|---------------------------------|
| Right superior | 4 | 0 | 8 |
| Left superior | 6 | 4 | 4 |
| Right inferior | 8 | 2 | 6 |
| Left inferior | 7 | 3 | 6 |
| Middle right ¹ | 1 | .. | .. |
| Not classified ² | .. | .. | 1 |
| | 26 | 9 | 25 |

It must be emphasized that the relation of the parathyroids to the thyroid and its capsule is not of necessity the same for the whole set of parathyroids in an individual; that is, if one glandule is close to or at a distance from the thyroid, it does not follow that the others in the same individual are in the same relative position; such may or may not be the case, as is shown by the following analysis:

Of the ten cases in which only two parathyroids were found, in two both would have been removed; in one instance they were the two superior parathyroids and in the other the two inferior parathyroids. In four of the remaining 8 cases one parathyroid would have been removed; in three of these an inferior and in one a superior. Of the four remaining cases, in two both parathyroids would have been preserved, in one case it was doubtful whether they would have been saved, and in the fourth case one would have been saved and one was doubtful.

Of the six cases in which three parathyroids were found, in one case all three would have been removed, namely, two superiors and one

inferior. Of the remaining five cases one parathyroid would have been removed in two instances; in one the right inferior, in the other the right superior.

In the five cases in which all four parathyroids were found, in one case all four would have been removed. In another three would have been removed; namely, two inferior and a right superior. In two cases two would have been removed; namely, the left inferior and the right superior in one case and the right superior and left superior in another. In the fifth case three would have been left; the fourth parathyroid (left superior) belonged to Class II.

Conclusions.—Although these figures and deductions have been arrived at through the study of the thyroid under practically normal conditions they are presumably approximately correct even under the somewhat changed conditions which prevail in connection with enlargement of the thyroid. That parathyroids are removed frequently in goitre operations has been shown by Iversen, MacCallum and others; there is, however, marked disagreement as to the frequency with which they are thus sacrificed.

It must be emphasized that the relation of the parathyroids to the thyroid and its capsule is not of necessity the same for the whole set of parathyroids in an individual.

In the 25 cases analyzed by us one (or more) parathyroids would apparently of necessity have been removed in an intracapsular lobectomy in 21 of the 50 lobes, or 42 per cent. The significant feature, however, is that two parathyroids would almost certainly be removed in a unilateral intracapsular lobectomy in 8 per cent. of individuals, and possibly removed in 6 per cent. additional cases (*cf.* Table II).

It must be confessed that our studies have not led to conclusions which warrant recommendations for radical departure from the generally accepted operative procedures. The most that can be hoped is that they will emphasize certain important anatomical features and perhaps lead to a clearer appreciation of the reasons for certain generally accepted principles in regard to the surgery of the thyroid. These principles may be briefly reviewed.

Since usually two parathyroids lie on each side, and inasmuch as two parathyroids apparently can satisfy the demands of the body, the chance that tetany will develop as a result of extirpation of one lobe is extremely remote. It is reasonably safe, therefore, as far as tetany is concerned, to perform complete intracapsular extirpation of one lobe, as is so often done, for instance, in exophthalmic goitre.

Attention must be called to the fact that in a considerable percentage

THE PARATHYROID GLANDS

of the reported cases of tetany which have followed operations for simple goitre the tetany has followed an operation upon the second lobe, one lateral lobe having been removed at a former operation. Such cases must be explained as follows: After extirpation of one lobe an operation upon the remaining lobe becomes necessary. Although the operator, who may be a different surgeon from the one who performed the first operation and not know the details of that operation, may elect resection or partial extirpation of the second lobe, conditions may be such as to divert him into the performance of complete extirpation of the second lobe. In such an operation parathyroids may be sacrificed, and if one or two parathyroids have already been removed in the former operation, parathyroid insufficiency and consequent tetany will result. It follows that *for the prevention of tetany the posterior part of the lateral lobe must always be left on at least one side*; it likewise follows that, even when one lobe only is operated upon, permanent safety is better insured by leaving *in situ* the posterior part of that lobe. Then, if a subsequent operation with complete removal or removal of the lower half of the second lobe becomes necessary, the operation may be performed with relative safety. Although the above condition rarely arises, one of the writers has seen two cases.³

In regard to safeguarding the recurrent nerve it may be emphasized again that in a true intracapsular extirpation of a lobe the recurrent nerve is relatively immune from injury. Nevertheless, as has been explained, the capsule may be torn at its posterior part and the cellular plane which contains the recurrent may be entered and the nerve injured. This danger is avoided by leaving a portion of the posterior part of the lobe.

To summarize: It is advantageous, but not imperative, to leave *in situ* the posterior parts of both lateral lobes in relation with each of which a recurrent laryngeal nerve and two parathyroids usually lie. Complete bilateral extirpation, the isthmus only being left, should never be considered. The posterior part of the one lobe must always be left.

The authors are indebted to Dr. Hermann Schulte and Dr. W. C. Clarke of the College of Physicians and Surgeons, Columbia University, for assistance in the preparation of this article; also to the French Hospital for the use of the laboratory.

³ Pool: Tetany Parathyreopriva, ANN. OF SURG., 1907, xlii, p. 507. Pool and Turnure: Post-Operative Tetany, Parathyroid Transplantation. ANN. OF SURG., 1912, lvi, p. 804.

NON-STRANGULATED DIAPHRAGMATIC HERNIA DUE TO INDIRECT INJURY*

BY DONALD C. BALFOUR, M.D.

MAYO CLINIC, ROCHESTER, MINN.

TRAUMATIC diaphragmatic hernia though not exceedingly rare is always a surgical curiosity. The condition presents features of interest as well as problems of considerable perplexity, since the successful repair of the injury may often be associated with baffling technical difficulties. Many of the large number of cases which have been described in the literature were found either at autopsy or when operating in an emergency, immediately after the injury or later for strangulation.

Reports of the radical cure of chronic non-strangulated diaphragmatic hernia of the traumatic type are, however, surprisingly few, and particularly rare are cases in which the abdominal route has been used. Binnie,¹ in 1914, stated that two cases only of the radical cure of strangulated diaphragmatic hernia were on record. These were both repaired through the thorax. McGuire² has had two typical cases. He used the transthoracic operation and thinks highly of it. I have recently had the opportunity to observe and then to operate by the abdominal route on a hernia of this type, and certain points noted, particularly in reference to the diagnosis and operative treatment, seem of sufficient value to be placed on record and to warrant a description of the case.†

The patient (136,932) was a railroad conductor, forty-seven years of age, who dated all the symptoms of which he complained from a railroad accident four years ago (August, 1911) when he was crushed under logs falling from a car. The severity of the injury may be judged from the fact that he was unconscious for six days with loss of bladder control for twenty days.

The patient's subjective symptoms were briefly as follows: Following the accident and the return of consciousness he began to suffer greatly from gastric distress which continued unabated and with spells of exacerbation up to the time of our examination. The distress, which was characterized as burning and crowding pain,

* Submitted for publication October 4, 1915.

† Dr. Crispin diagnosed the case and furnished the records for the history.

DIAPHRAGMATIC HERNIA

at times increasing to a colic, began in the epigastrium and radiated toward the left and into the left chest. It came on, as a rule, about two hours after meals and often lasted from twelve to twenty-four hours. The first solid meal he ate, one month after the injury, "nearly killed him." Since the accident he has not been able to eat heavy food and he has never obtained relief from any kind of diet, ingestion of food always aggravating the symptoms. There was a marked dyspnœa for many days following the injury and he was not able to lie down in bed. Gradually this became less evident. He was frequently aware of gurgling and rumbling in the left chest. Strong cathartics were continually necessary and free evacuations were followed by temporary ease of abdominal distress.

Physical examination of the chest disclosed several very interesting facts. The heart was displaced to the right, lying more or less in a median position. The auscultatory signs over the left chest suggested the diagnosis. Under forced respiration splashing sounds of fluid and air were heard as high as the left nipple to the left and above the apex. There appeared to be good expansion in the left upper chest, and the breath sounds were not greatly impaired. An area of tympany existed back of the posterior axillary line and reached up to the scapula. The physical signs showed considerable variation under different postures; for example, when the patient was put in an exaggerated knee-chest position the breath sounds in the left chest became markedly suppressed and the percussion note lacked the resonance of the right side. When he was in a sitting position tympany disappeared. Litten's sign on the right side was well marked and definite; on the left side, however, it was absent and in its stead there was an upward filling of the fourth and fifth intercostal spaces anteriorly from the left sternal margin to the nipple line.

Fluoroscopic examination showed the left diaphragm at about the fifth space or sixth rib. Gas bubble in the stomach reached to the fourth rib. The left diaphragm did not reverse with respiration, but action was greatly delayed in the usual direction. The röntgenogram, after using bismuth in both stomach and bowel, showed the stomach to lie high in the left chest; it was distorted and partly rotated. The colon occupied the upper part of the left thoracic cavity, the splenic flexure rising above the level of the sternoclavicular union (Figs. 1 and 2).

In 1912 Giffin³ made an extensive review of the literature and presented the detailed history of a patient examined and operated on by W. J. Mayo. He called attention to the important points of differential diagnosis. One of the most difficult differentiations is between trau-

matic diaphragmatic hernia due to indirect injury and elevation of the diaphragm (eventration). This depends largely on the röntgenologic findings. The most important evidences in favor of hernia are: (1) A destruction of the definite dome-shape which is characteristic of the normal line of the diaphragm; (2) the appearance of lung tissue through the gas bubble in the left chest; and (3) the demonstration of bismuth in the colon above the level of the bow-line in the chest. The findings in my case corroborate Giffin's statement as to the importance of the position of the colon with reference to the level of the bow-line in the chest. This point has not been emphasized in the literature, but the finding in my case left no doubt that the condition was due to diaphragmatic rupture rather than to elevation of the diaphragm.

Operation (August 7, 1915).—Performed under intratracheal ether anæsthesia (Robinson method and apparatus ⁴) with the patient in a moderate reversed Trendelenburg position. The Bevan incision was made at the outer border of the left rectus and continued up to and along the left costal margin toward the midline, an incision similar to that used in performing splenectomy. It was immediately evident that several feet of jejunum had entered the left chest. This was removed and it was then possible to introduce a hand in front of the colon and stomach and, by careful traction on these viscera, with the aid of the hand in the thoracic cavity, all the displaced abdominal organs, except the spleen, were evacuated. This was not easily accomplished, since with each inspiration the organs were sucked back into the chest with the most surprising force and rapidity. Adhesions complicated the removal of the spleen and it was the last organ to be replaced. No serious damage was inflicted, however, the two superficial lacerations being later repaired by catgut sutures. Having succeeded in replacing the various organs in the abdominal cavity, long retaining packs were introduced, and with the aid of the spread-out hands of an assistant the stomach, colon and spleen were prevented, with considerable difficulty, from being sucked back into the thoracic cavity.

An opportunity to view the defect in the diaphragm was then afforded for the first time. The opening occupied the central part of the left half of the diaphragm; it was roughly circular in outline, with its greatest diameter anteroposterior and the average diameter about seven inches. The edges of the opening were thickened and rounded and appeared as if they would lend themselves to direct apposition without the necessity of "freshening" the edges.



FIG. 1.—Stomach in the left chest.

1332

FIG 2 —Colon in left chest.



FIG. 3 -- 1. Defect in diaphragm exposed. Continuous suture of double chromic catgut begun.
 B. Method of picking up the posterior margin of diaphragmatic opening.



FIG. 4 --Röntgenogram of stomach following operation.



FIG. 5.--Colon following operation.

DIAPHRAGMATIC HERNIA

The method of closing the defect, while simple, is perhaps deserving of particular reference, as it undoubtedly facilitated a satisfactory closure. A long strand of double No. 2 twenty-day chromicized catgut was used. The suturing began at the anterior part of the opening, this being the most accessible part of the defect; the edges of the opening were approximated by the running suture, aided by traction forceps placed at suitable points beyond the margins (Fig. 3A). The suturing was continued until about two-thirds of the opening was closed, when it was found that the remaining posterior one-third of the defect, which was the most difficult of access, could be best obliterated by picking up the most distant edge of the opening and the closure continued on a line at right angles to the first part of the closure (Fig. 3B). This permitted not only complete apposition of the margins of the opening with a moderate amount of tension, but also a certain amount of overlapping. Interrupted reinforcing sutures of doubled fine silk were now used to protect the continuous line of absorbable suture material.

More careful examination of the stomach showed the presence of two ulcers, the larger one on the lesser curvature one and one-half inches from the pylorus, forming a suspiciously hard mass the size of a walnut; the second at the outlet of the stomach on the posterior wall and seemingly causing slight obstruction.

The etiologic factors of the gastric lesion are problematic, but it is very suggestive that all of this patient's gastric trouble dated from the time of his injury, and it is more than possible that the new position of the stomach in the chest, with the attendant unusual tension, thus rotating the stomach in such a way that the lesser curvature impinged on the margins of the opening, may have been the real factors in the production of the ulcers. It will be very interesting, therefore, to follow the future history of this patient to determine whether the replacement of the stomach to its normal position will be followed by relief of the gastric symptoms.

From the surgical stand-point the choice of the route used to gain access to the damaged diaphragm lies between the thoracic, the abdominal, or both. Many surgeons have advocated the transthoracic operation, but in previous cases from our Clinic reported by Beckman⁵ the abdominal route seemed to be indicated. It was particularly satisfactory in the above cases. Advantages may be claimed for each method and, while in certain of the non-strangulated chronic types of diaphragmatic hernia the thoracic route may be advisable, inasmuch as complications may call for the abdominal route it is well to be familiar with the method. While Binnie's¹ excellent statistics show

a much higher mortality by the abdominal route, it should be remembered that his figures were based on emergency cases, and that in this group of acute cases (stabbing injuries, gunshot wounds, etc.) the very urgency may be due to the serious damage of abdominal viscera with the necessity for the abdominal route in these more critical cases.

The patient in this case was ready to go home three weeks after operation, when he developed a subacute intestinal obstruction and an emergency operation was done. A loop of small intestine was found adherent to the original incision. Separation of this was followed by relief of symptoms and good recovery. Thus far there has been no recurrence of gastric distress. Before he left the Clinic a careful record was made of the physical findings, which showed that the lung was rapidly expanding and the heart assuming its normal position. Röntgen examination of the stomach and colon showed them in their normal positions (Figs. 4 and 5).

REFERENCES

- ¹ Binnie, J. F.: *Manual of Operative Surgery*, Philadelphia, Blakiston, 1913, p. 573.
- ² McGuire, S.: Diaphragmatic Hernia, in his *Profit and Loss Account of Modern Medicine*, Richard Jenkins, 1915, 305-312.
- ³ Giffin, H. Z.: The Diagnosis of Diaphragmatic Hernia, *ANNALS OF SURGERY*, 1912, 1v, 388-397.
- ⁴ Robinson, S.: An Apparatus for Thoracic Surgery under Intratracheal Insufflation of Positive Pressure; also for Ether Anæsthesia by Mask, Intra-pharyngeal, Intratracheal and Intra-buccal Methods. *Surgery, Gynæcology and Obstetrics*, 1912, xiv, 462-469.
- ⁵ Beckman, E. H.: Diaphragmatic Hernia, with Report of Three Cases. *Surgery, Gynæcology and Obstetrics*, 1909, ix, 154-156.

THE USE OF FREE OMENTAL GRAFTS IN ABDOMINAL SURGERY*

BY LEONARD FREEMAN, M.D.
OF DENVER, COLORADO

ALTHOUGH the omentum is constantly before the abdominal surgeon, even in his way, there seems to be a general failure to recognize the important surgical uses to which it may be put, and especially is this true of free omental grafts.

A well-known function of the omentum is its almost intelligent inclination to seek out and attach itself to raw or inflamed surfaces, wrapping itself around them in such a way as to afford a maximum of protection. When the inflammation has subsided or the need for protection has ceased, these adhesions tend to disappear, however firm and voluminous they may be; so that if the abdomen is again opened, slight if any vestige of them will be found. Every surgeon must be familiar with this striking phenomenon. In other words, Nature often uses the omentum within the peritoneal cavity much as a surgeon employs adhesive plaster or a dressing externally—for temporary protection only.

This marked inclination of the intact omentum to adhere to its surroundings is also possessed by free omental grafts, which always may be transplanted with great certainty except in the presence of actual suppuration. When this fact is thoroughly appreciated the way is open to a variety of useful and even life-saving plastic procedures, such as the replacement of lost portions of peritoneum, the prevention of adhesions, the strengthening of suture lines, the occlusion of the pylorus or of the intestine, and the checking of hemorrhage.

The Replacement of Lost Portions of Peritoneum.—When this can not be done with peritoneum itself, by means of flaps, folds, or convenient transplants, an omental graft of any desirable size may be employed. The necessity for such grafting may arise anywhere in the abdomen, and the covering in of a large or even a small raw surface may sometimes prevent subsequent complications due to inflammations or adhesions. The advantage of using a free graft rather than an attached portion of omentum is obvious, because the latter may give rise to entangling bands or to injurious traction upon the colon, the duodenum or the stomach—in fact, I have seen a death from acute

* Read before the New Mexico State Medical Society, September 7, 1915.

dilatation of the stomach arising from a pull of this kind. In addition, when the omentum is permanently attached to a certain spot, its action is prevented in other portions of the abdomen where it might urgently be required.

In a number of instances I have used an omental graft to cover the large raw surface resulting from the "unfurling" of a Lane's kink, and I wish to emphasize the advantage of this and especially the security against recurrence thus obtained.

The Prevention of Adhesions.—This is a question which has given rise to much controversy, the very multitude of suggested methods serving to cast doubt upon the reliability of any particular one. However, the experiments of Sweet, Chaney and Willson¹ upon dogs, and the observations of Iselin² and others seem to show that the formation of permanent adhesions undoubtedly can be prevented by the use of omental grafts.

Although this may seem paradoxical at first thought, because of the tendency of the omentum to form adhesions, it ceases to be so when we remember the equally decided inclination of these adhesions rapidly to disappear when the irritative cause has subsided. In this connection an observation made by Iselin² is of much interest. He covered a raw peritoneal surface upon the mesentery with a free omental graft the size of the palm of a hand, and at an autopsy made seven days later the transplant was found not only grown in place, but its surface was glistening and free from adhesions. I frequently have employed transplants from the omentum to replace lost portions of the intestinal peritoneum resulting from the separation of adhesions, and although I have had no opportunity of checking up the final results by autopsy, they have nevertheless always been satisfactory.

There is but little reason to suppose that dead membranes of any kind, such as Cargile membrane (prepared peritoneum of the ox), or amniotic membrane (recently suggested by Lyman, of Denver), act otherwise than irritating foreign bodies, producing adhesions rather than preventing them, as has been demonstrated by experiments on animals made by Craig and Ellis.³

The Strengthening of Suture Lines in Operations Upon the Stomach and Intestines.—Free omental grafts are well adapted to this purpose, especially in the absence of great tension or of actual gaping of the wound. When those are present the use of fascia lata is perhaps to be preferred, as it also is in certain resections of the rectum and colon. The size of the transplant should be sufficient to reach well beyond the line of suture on either side, so as to obtain a firm hold upon the

USE OF FREE OMENTAL GRAFTS IN ABDOMINAL SURGERY

adjacent surfaces, and security against displacement must be assured by numerous catgut stitches.

Pyloric and Intestinal Occlusion.—A band formed from a free omental graft may be employed to close the pylorus in gastro-enterostomy or to exclude portions of the intestinal tract, such as the proximal colon in ileosigmoidostomy. For such purposes the omentum divides the honors with fascia lata and the round ligament of the liver. The method of use is to twist a strip of omentum into a cord which is passed once or twice around the distal end of the stomach or around the bowel, drawn tight, and held by appropriate sutures. Such living ligatures do not have the same tendency as do other kinds to become absorbed or to cut their way into the lumen of the bowel; but they rather incorporate themselves with the surrounding tissues, thus insuring more or less permanent results.

The checking of hemorrhage from raw surfaces, especially of the liver, spleen and pancreas, is an important use for free omental grafts which cannot be too strongly emphasized and which I am sure is not sufficiently well understood.

An omental graft when spread upon a bleeding surface of a parenchymatous organ at once checks the oozing however free it may be, even, at times, if spurting vessels of some size are present. This is a fact first recorded by Loewy, in 1901, and since then substantiated by many observers, including the writer, both in the laboratory and in the operating room. The phenomenon is due, perhaps, partly to mechanical effect, in the shape of mere adhesion, and partly to a biochemical activity causing coagulation, which the omentum is supposed to possess in common with certain other tissues, such as fat, muscle and fascia.

It is scarcely necessary to call attention to the great usefulness of the procedure in various accidental and operative wounds of the liver and spleen. In rupture, for instance, an omental graft may be used as a tampon in place of gauze, to which it is immeasurably superior, because it is more effectual and is less likely to cause infectious difficulties and necrosis of the tissues.

Wound surfaces remaining after cholecystectomies can generally be closed by catgut sutures, but occasionally this cannot be done and great difficulty is experienced in checking the oozing which is at times alarming. Under such circumstances an omental graft pressed upon the denuded area will at once produce hæmostasis which is both reliable and permanent. In fact, the abdomen may often be closed without the usual gauze packing, so difficult and painful to remove and so often leading to troublesome after-effects, such as infection, hernia, and pro-

longed convalescence. An end of the same graft may also be used to cover the stump of the cystic duct, thus helping to insure against leakage. Of course a sufficient number of catgut sutures must be inserted to guard against shifting of the transplant; and where an actual wound of the liver is present the living tampon should often be sewed in position by sutures which penetrate deeply through both the liver and the inserted omentum.

With such a reliable aid to hæmostasis I feel sure that surgeons often should no longer content themselves in difficult cases with inefficient cholecystostomies when a cholecystectomy is really indicated. In at least two cases, for instance, I have been able to control alarming hemorrhage and easily bring to a favorable termination an otherwise fatal condition.

The technic of omental grafting is very simple, but there are certain precautions to be observed: (1) In tying off the graft a sufficient number of ligatures should be used so as not to pucker the pedicle into too much of a bunch. (2) The excision should be made as far from the base and as near the free border of the omentum as possible, and an effort made to avoid the larger vessels, for reasons mentioned farther on. (3) No more tissue should be sacrificed than is actually required. (4) The grafts should always be held in place by a number of stitches of fine catgut, in order to guard against their shifting. Silk or linen sutures are unnecessary, owing to the remarkable rapidity with which adhesion of the grafts occurs. (5) The transplant should entirely cover the raw area and project over the sound tissues on every side.

While recognizing in general the value of omental grafts, there are certain objections to them which should prevent us from employing them too hastily. They are of four kinds: (1) The production of multiple foci of hepatic necrosis; (2) the causation of gastric and duodenal hemorrhage; (3) the loss of a useful organ which might be required for other purposes; and (4) the production of a raw omental stump capable of forming objectionable or even dangerous adhesions.

No one of these objections is, however, of much force, because the probability of their occurrence is remote to say the least. The greatest interest attaches itself to gastric hemorrhage (von Eiselsberg) and hepatic necrosis (Friedrich). They are both probably due to emboli arising from thrombosis of the vessels following ligation of the omental tissues.

According to Friedrich,⁴ if the thrombus is venous and extends upward far enough to reach the right epiploic vein, emboli may be washed

USE OF FREE OMENTAL GRAFTS IN ABDOMINAL SURGERY

off and carried through the portal circulation to the liver. Small, multiple areas of necrosis are produced in this way, possibly accompanied by jaundice, thus explaining obscure instances of icterus following abdominal operations. On the other hand, if the thrombus is arterial, it may travel backward into the right epiploic artery and give rise to emboli which block the end-arteries of the stomach, causing gastric hemorrhage, usually of the "capillary" variety. It is also possible that ulcers might result in this way, as has been demonstrated by animal experimentation.

Out of a number of instances in which the omentum was ligated, I recall but two where capillary hemorrhage from the stomach occurred, neither of which was serious in its results. In fact, such happenings "belong among the rarest clinical phenomena" (Friedrich), and when they do appear the prognosis is usually good; but this should not prevent one from bearing them constantly in mind.

It is obvious from the above considerations that in ligating the omentum the larger vessels should be avoided, and that the farther the ligature is placed from the base of the structure the less the danger of a thrombus extending far enough to give rise to emboli. The anatomical peculiarity that the omentum is shorter in men than in women may have a bearing upon the interesting clinical fact that gastric hemorrhage has been observed almost exclusively in the male. When the omentum is unusually short, one should perhaps be more than usually cautious about interfering with its circulation.

LITERATURE

¹ Sweet, Chaney and Willson: *ANNALS OF SURGERY*, vol. lxi, p. 297, 1915.

² Iselin: *Zeit. f. Chir.*, June 1, 1912.

³ Craig and Ellis: *ANNALS OF SURGERY*, vol. xli, 1905, p. 801.

⁴ Friedrich: *Archiv. klin. Chir.*, B. 61, H. 4, s. 998.

⁵ Crouse, Hugh: *The Omentum. Its Embryology and Histology.* Bull. El Paso Med. Soc., 1915.

ON LIGATION OF SPLENIC VESSELS AS A SUBSTITUTE FOR SPLENECTOMY IN BLOOD DISEASES*

ALSO A CONTRIBUTION TO THE PATHOLOGY OF THE INFARCTS OF THE SPLEEN

BY ABRAHAM TROELL, M.D.

DOCENT OF SURGERY, STOCKHOLM, SWEDEN

(From the Department of Pathology, College of Physicians and Surgeons, Columbia University, New York)

THE removal of the spleen—an operation which is said to have been already performed during the Middle Ages (Carstens⁹) and which nowadays without question plays the most important rôle in splenic surgery—has in the last few years been gaining a great deal as far as its indications are concerned. For, according to the experience of unquestioned authorities, it has given favorable results in certain blood diseases, particularly morbus Banti and pernicious anæmia. Banti himself as well as others^a gives reports of cases of the former disease which, operated on in an early stage, have completely recovered and have been doing quite well as long as four years after the splenectomy. As to the pernicious anæmia certainly a perfect health has not yet been established in any case in regard either to the general condition or to the blood picture of the patient, but an improvement has been noted, in some instances so direct and striking that it could hardly be due merely to one of the ordinary fluctuations in the run of this disease.^a Furthermore it has been shown, both by experiments and through clinical experience, that, from a physiological point of view, the spleen is not an absolute necessity for the organism. As far back as 1841 Bardeleben¹⁰ found this to be true in animals, and numerous observations made upon patients who have undergone splenectomy have shown them to be in good health many years after, Adelman's¹⁸ case, for instance, 23 years. Thus there is no doubt that the operation as a matter of principle is justifiable.

* These investigations were carried out in the laboratory of Dr. W. G. MacCallum (Professor of Pathology, College of Physicians and Surgeons, Columbia University, New York) during the winter semester 1914-1915, and I am very much indebted to him, not only because he has granted me a place in his laboratory, but also for the great interest he has always shown in my work during this time and through which he in every way made it possible for me to undertake it and bring it to an end.

^aMoynihan and Upcott, Michelsson, K. Ziegler, Poppert, Dahl, Stapelmohr, Roblee, Moffitt, Rystedt, etc.

LIGATION OF SPLENIC VESSELS

However, it involves a considerable immediate risk. Every one who has had to operate upon individuals greatly debilitated by blood diseases, as well as he who on account of such a condition has refrained from operating, is aware of this. Splenectomy is particularly dangerous where adhesions from perisplenitis increase the difficulty in removing the organ (if not making it altogether impossible) and increase the chances for fatal bleeding.^b In the 33 cases of splenectomy for pernicious anæmia that Moffitt has recently collected and published 8 fatalities had happened in direct connections with the operation. In Banti's disease the operative mortality is estimated at 50 per cent. (K. Ziegler). Indeed, the real mortality for all operations performed in these diseases is not small.

With this fact in view the thought has occurred to me that it might be possible to get similar results or at least nearly similar results for these patients through a simpler and less dangerous operation than splenectomy. I mean by *ligation of a larger or smaller number of splenic vessels*. Since in morbus Banti and pernicious anæmia a complete elimination of the function of the spleen has a favorable effect upon the organism, then a partial lessening of its function ought to affect the metabolism beneficially too. For a long time, and for good reasons, we have accepted an analogous way of thinking in regard to another ductless gland, viz., the thyroid, in its relation to Graves's disease. Such a clinician as Hälsted, whose experience and critical way of thinking are well known, speaks in favor of this operation. And on the whole the clinical experience has proven this unmistakable, even though there has been a theoretical doubt as to the effectiveness of the operation because of the great number of anastomosing vessels, giving a very rich vascular distribution to the gland.^c

I have searched through the literature for notes on the ligation of splenic vessels for the purpose mentioned above. The idea of this operation seems in fact so natural, that its earlier origin in the minds of others is not at all surprising. On the contrary, it is strange that it has not as yet led to the thorough investigation of its presumptive value.

In the chapter on "Surgery of the Spleen" in the large surgical text-book of Keen, Moynihan and Upcott make the following statement concerning partial ligation of the hilum of the spleen: "It has been shown experimentally that reduction of the blood-supply by ligation of some of the arterial branches entering the spleen results in atrophy of the organ, and as long as veins are left intact necrosis will not occur." However, I have not been able to get any further

^b *Cfr.* Fischer, Roblee and others.

^c *Vid.* for instance, Landström: Morbus Basedowii, Nord. med. arkiv., i, 1907.

information as to this investigation as no one of the papers referred to by them contains the original statement and they do not give reference to authority. Most of the other accounts in the literature concern the ligation of all splenic vessels. In order to find a method of operation in traumatic splenic bleedings—ruptures, gunshot wounds, etc.—Girgolaw and Sheldon ligated the whole hilum of the spleen in dogs, a method first advanced by Jonnesco.³³ Both undertook the operation on three dogs, all of which died from intoxication by the decomposition-products of the spleen. To prevent this, Sheldon has followed Pirone's³⁴ suggestion and sewed up the large omentum all around the spleen, thus hoping to get a new blood-supply to the organ. Nevertheless, the animals died after 12 to 48 hours, and at the autopsy the spleen was found necrotic throughout. The statements of Long and Lanz are based upon clinical experience, each one reporting a case of ligation of the splenic artery in "fixed floating spleen." In such a disease, not menacing the life of the patient, Lanz advises "in complicated cases," instead of splenectomy, that ligation of the splenic artery be performed as it is less dangerous but equally effective. In his case, he claims to have found clinically, half a year after the operation, a "complete disappearance" of the spleen (?). He ends his paper as follows: "If, in a case of pernicious anæmia, the chances should be in one way or another unsafe as to splenectomy, then—according to my experience,—the ligation of the splenic artery might be recommended." Finally, Foà gives a quite opposite suggestion. Starting from the fact that he has seen experimental tuberculosis in the liver of guinea-pigs cured after tying the splenic vein, which organ at the same time atrophied, he thinks it might be well to ligate the splenic vein in those cases of Banti's disease in which the spleen is not removable.⁴

The suggestion of ligating a part of the splenic vessels in order to produce a reduction in the functions of the organ leads at first to the following questions:

How will the organ be affected anatomically? and what will be the result on the function of the spleen?

I have tried to get information on these subjects by experiments on animals. Having ligated one or more vessels in the splenic hilum, I have kept the animals alive a longer or shorter period, after which, through another laparotomy, I have controlled the anatomical effect. I have given particular attention to the presence or absence of infarcts in the spleen and to signs of post-operative infection. As far as the physiological side of the subject is concerned, I intended from the beginning to get light on it by counting the blood-corpuscles before the operation as well as a couple of weeks afterwards, both in the afferent and efferent splenic vessels and in a vein in some other part of the body

⁴According to Michelsson, ligation of the splenic vessels in fixed malaria-spleen has been suggested by Clement-Lucas and carried out by Meierowitsch (and Wyman?). Michelsson—who does not give the exact reference for any of these authors—does not think this operation to be preferable to splenectomy in malarial spleen.

(the ear). The difference between the number of blood-cells in the vein and in the artery of the spleen ought, if the spleen plays any rôle in regulating the quantity of blood-cells in the general circulation, to differ in these two instances, and from that difference I expected to be able to judge whether the function of the spleen has been retarded or not. Yet I may at once admit that my chances in this respect were not very great as to a positive result, since the investigations so far made on the functions of the spleen have led to contradictory conclusions. There has been attributed to the spleen, among other things, a rôle of formation of blood-cells as well as one of destruction of them. Clinicians to-day generally hold that the spleen, as far as the blood is concerned, has to destroy old, useless erythrocytes and to regulate the throwing into the circulation of new elements from the bone-marrow and other blood-forming organs.^e There are, however, even recent investigations (Morris) which are in favor of the theory that the spleen in adults, too, is a blood-forming organ.

There is one more detail in the arrangement of my investigations to be mentioned. For, in case of success in my attempt to produce what I in the first place expected, an infarct, I had to take into consideration a fairly important point. Against the use of such an operation on human beings the objection could be made that the production of a large necrotic piece of tissue in the abdominal cavity might mean a great risk of secondary infection. Realizing this, I infected three of the animals with ligated splenic vessels through the intravenous injection of staphylococci or coli bacilli one to one and a half weeks after the primary operation.

On account of space I do not give here a detailed report of my experiments (these will soon appear in a paper in the Swedish journal, *Svenska läkaresällskapets handlingar*). However, I wish to make a few technical remarks. Before the operation I made a blood test from the ear vein of the animal and counted the number of blood-cells. All the operations were performed under ether (between 10 A.M. and 2 P.M., the animals were fed at 5 P.M.; thus a possible leucocytosis of digestion should have played about as little rôle in one case as in another). The spleen was exposed by an incision parallel to and just below the costal margin. Through a slight pulling on the stomach wall the spleen was brought outside the abdominal wound and then protected with warm saline cloths. As much care as possible was taken to avoid direct handling and squeezing of the spleen as well

^eSee Johnston, Pearce (and collaborators), Thévenot, Hedenius, Moffitt, Dahl, A. Meyer (thorough paper on the relation of the spleen to the metabolism), King, Roblee and others.

as pulling and traction upon its vessels; this in order to exclude error in the blood-counts. After having located the topography of the vessels, I first punctured a vein and then an artery with a fine suture needle. From each vessel I took blood in a pipette for white and red blood-cells and mixed as usual with Hayem's solution and $\frac{1}{3}$ per cent. acetic acid. At my first operations I also made smears for differential counts of the white blood-cells (Giemsa stain). Finally, the number of vessels I wanted to ligate were tied with a linen thread, the spleen was replaced in the abdomen, the wound closed and the animal left to recover. All counts of the blood-cells were made by myself, using a Thomas-Zeiss apparatus; 100 squares for the red cells; the whole chamber for the white being counted.

The operations were so far successful that peritonitis never occurred. Healing followed without any trouble, the animals recovered very soon after the operation and, with some few exceptions, seemed to do very well.

I performed in the beginning a series of operations on 12 animals. From 1 to 5 each of the arteries and veins in the splenic hilum were tied, always as many afferent vessels as efferent ones, and in that way, as a rule, at least one artery and one vein were left untouched; with the exception of one of the guinea-pigs where all of the vessels at the hilum of the spleen were tied.

The anatomical effect in the large animals (eight dogs and one cat) of this series was negative, so far as I could judge, in six instances but positive in three. Every one of the three guinea-pigs showed marked changes in their spleens.

In the six animals first mentioned I could not find any evident abnormality in the splenic tissue at the autopsies undertaken, 13 days to $2\frac{1}{2}$ months after the operation. This was the fact even in those two cases (Nos. 2 and 6) which, having been quite well up to the time of death, died spontaneously three weeks after the operation. One dog (No. 8), however, showed, 10 minutes after the ligation, multiple infarction of the periphery of the spleen in an early stage (Fig. 5); one cat (No. 9) after five hours, showed a diffuse infarction of the organ; and another dog (No. 5) after 13 days, showed a small hemorrhagic infarct in the upper part of the spleen.

As to the guinea-pigs, the effect was more noticeable. The size of the spleen in each case was greatly reduced, in proportion to the number of vessels ligated. Thus the animal in which two arteries and two veins were left untouched at the operation, showed, $1\frac{1}{2}$ months later, a spleen somewhat larger than that in which just one artery and one vein had been left; while in the guinea-pig with its whole hilum tied,

LIGATION OF SPLENIC VESSELS

the spleen was smallest. Yet in these three animals there was a general reduction of the organ without any visible signs of infarction.

Thus the results of this series of operations in a way were not very encouraging in view of what was expected. Particularly striking was the fact that infarction in so many cases did not occur, though I sometimes ligated as many as 4 out of 5 large arteries and veins, and although I always found my ligatures all right at the autopsy. It is to be regretted that at these first operations I had not taken an exact measurement of the spleen and thus could not later on tell whether the size of the spleen in the larger animals had been reduced after the ligation of the vessels. In the guinea-pigs this was an easy matter, as the decrease was so marked.

Evidently, the cause of the non-infarction should be found in the anatomical arrangement of the vessels. And yet at first, I was unable to determine exactly how, due largely to the fact that the distinguishing of the different parts in the gastrosplenic ligament (which in dogs is very broad) had mostly become rather difficult because of adhesions and kinking after the ligation. The fact was made clear, however, through one of the animals last killed (Case 1). In this specimen it was easily seen that distal to the place of ligation (Fig. 1)—which is indicated on the photograph by a pin through a paper cross—there was a transverse, broad vascular anastomosis, establishing a communication between the periphery of the tied vessel and the non-ligated vessel nearest to it. (This was found in the artery as well as in the vein, though the figure shows only the vein which afterwards was filled with a 5 per cent. collargol solution in order to render it more visible; for the same purpose a small piece of paper was placed under it). The main reason for ligating the splenic vessels at a point situated so proximally in the hilum was a technical one. With the intention of doing a blood count from vein and artery, I wished as much as possible to avoid handling and squeezing the vessels which I was going to puncture and then ligate; otherwise a disturbance might easily have been brought about in the physiological differences which I figured to exist in the amount of blood-cells in the artery and the vein. Thus I chose proximal places because the technic became simpler in that way—yet the vascular lumina not even here being very great on the animals operated on.

When I started operating upon my first series of animals, I undertook it with the idea in mind which has been found in anatomical textbooks for a long time (*e.g.*, Henle) and according to which the arteries of the spleen do not communicate with each other, either before enter-

ing the organ or after (*cf.* Fig. 2, from Gray). I had no idea of the fact that anastomosing branches which exist between the splenic and the gastro-epiploic vessels could be so extensive as it afterwards appeared from the real effects of my ligations and as it was indicated from the findings in Case 1. Having stated this, however, I naturally felt very anxious to get reliable information on this point. Therefore I injected colored gelatine solution into the splenic arteries of fresh autopsy material, from dog as well as from man—stomach, spleen and pancreas being dissected out together.¹ There is no need of many words to emphasize how clearly the pictures (Figs. 3 and 4) bring out the rich supply of transverse communication between the vessels of the spleen hilum. The first photograph refers to the spleen of a normal dog, the second to that of a child one year old (the picture here seen was the same in principle in the other two human spleens which I examined for the same purpose). In the two cases shown in Figs. 3 and 4 the injection was performed at the point shown by the pin. After the injection, in order to show the details, all the veins as well as the peritoneal sheaths were dissected off. For the fixation 5 per cent. formalin was used. The specimens show, on the one hand, the presence not only of slight connections but also of very *wide and sturdy transverse communicating branches between the various vessels in the splenic hilum*. And, on the other hand, they present evidence that for the most part, *these transverse anastomoses are located quite close to the concavity of the spleen*. I have in many cases found them to be so distributed that one might reasonably speak of a marginal artery and vein, which is in communication with the spleen through short branches. In view of such a supply of vessels it is evident that, even without attaining an immediate and complete stoppage of the circulation, such as would be a necessary condition for infarction, it is quite possible to ligate several arterial branches, particularly by doing so at a sufficient distance from their entrance into the spleen.

By ascertaining the anatomical state of the vessels, a neglect of which explains the negative results of my first series of experiments, I found it very desirable to undertake a new series of ligations. In this series care should be taken, in order to cut off the blood supply to a certain part of the spleen, to place the ligature distal to the transverse branches extending between the individual arteries, or a supplementary ligation of the corresponding transverse anastomosing branches should be made. This second ligature should, therefore, be placed and tied in the direction

¹For the spleen of the dog the gelatine was colored with Prussian blue, for that of the man with vermillion red.

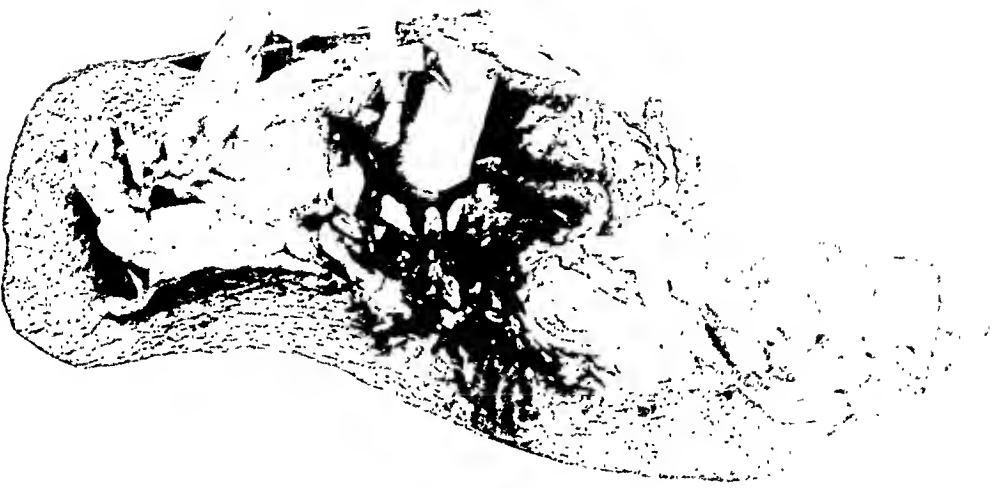


FIG. 1.—Case I. Distal to the place of ligation, which is indicated by a pin through a paper cross. There is a transverse, broad vascular anastomosis, establishing a communication between the periphery of the tied vessel and the non-ligated vessel nearest to it.

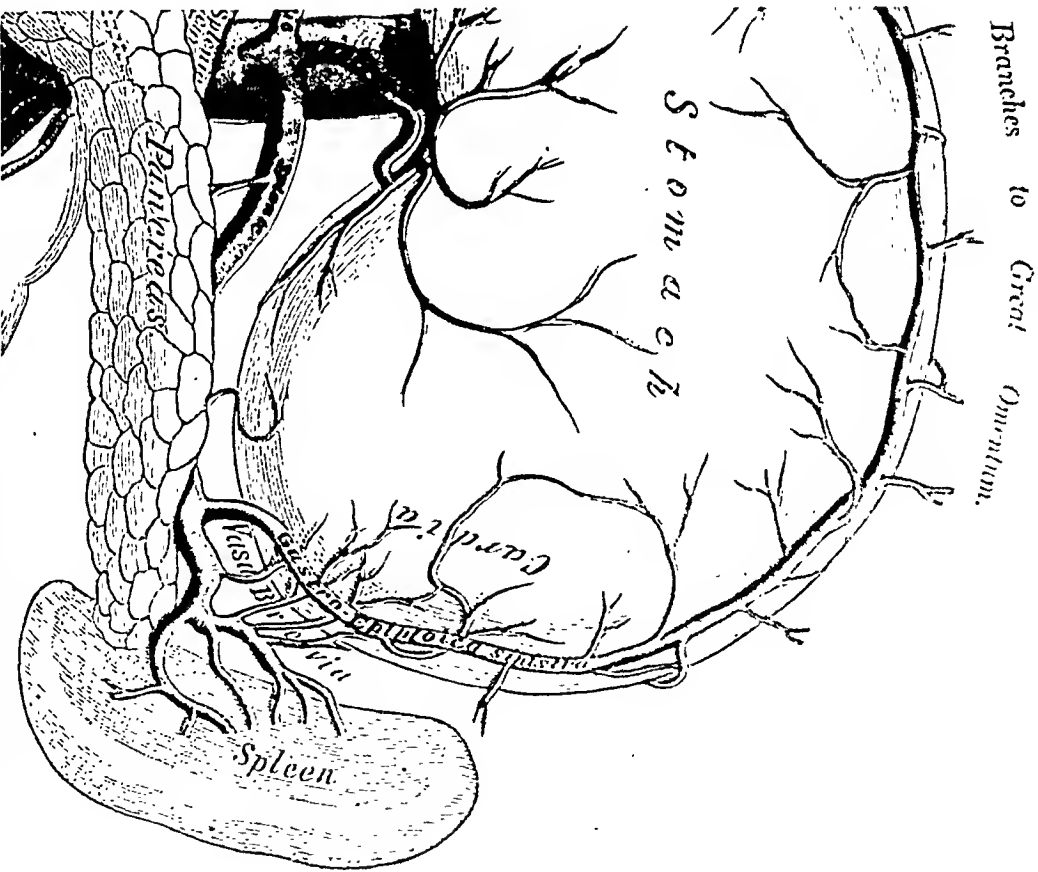


FIG. 2.—Showing that the arteries of the spleen do not communicate with each other (from Gray's Anatomy).



FIGS. 3 and 4.—From dog and man respectively. Showing the rich supply of transverse communication between the vessels of the spleen hilum; the anastomoses are located quite close to the concavity of the spleen.



FIG. 5.—Case VIII. Ten minutes old, multiple hemorrhagic infarction, localized to the edges of the spleen.

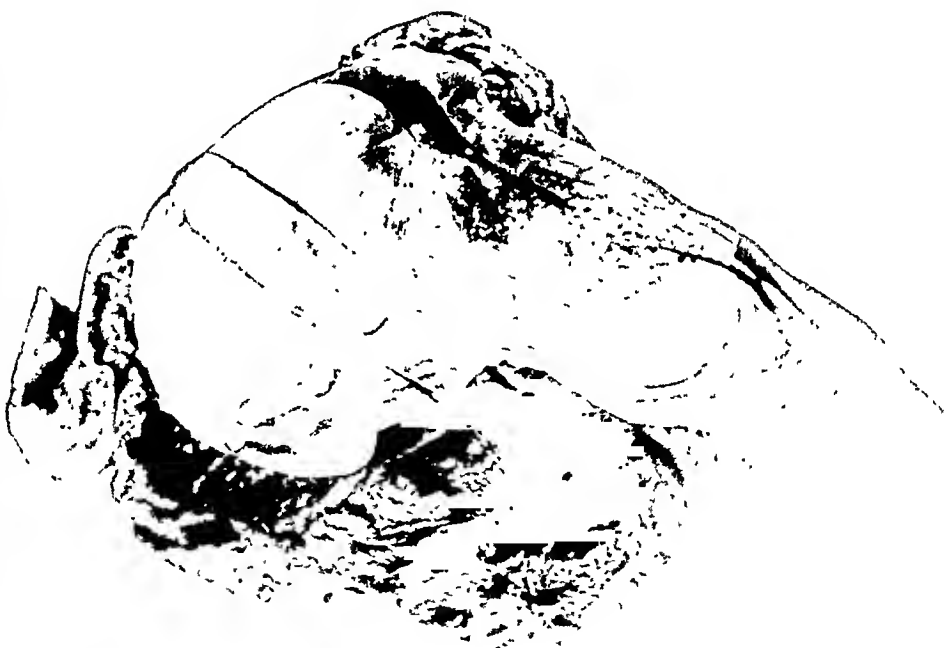


FIG. 6.—Case XXI. Three days old infarction of the lower end, to a less extent, upper poles of the spleen.



FIG. 7.—Case XX. Four and one-half weeks old infarcts, extended over the entire cross-section of the spleen. Case XVI. Spleen with its upper pole reduced to a pale shrunken infarct, 6 mm. long and 3 mm. deep; four and one-half weeks old.



FIG. 8.—Case VIII. The microscopical appearance of a ten minutes old infarct; through an enormous over-supply of red blood-corpuscles the spleen cells are made more attenuated than usual, the malpighian bodies, as well as the trabeculae, showing no visible changes.



FIG 9.—Case XX. The histological picture of a four and one-half weeks old infarct, being in the state of organization; necrosis and, to a certain degree, reabsorption have begun. A part of the infarct remains in the shape of a central, hyaline, eosinophilic mass, at the periphery of which there is a reaction zone rich in cells and pigment.



FIG. 10.—Case XVIII. The histological appearance of a four and one-half weeks old, organized infarct, consisting only of connective tissue rich in vessels, and to a great extent, containing pigment, intracellularly and extracellularly.

LIGATION OF SPLENIC VESSELS

of the ligamentum gastrosplenicum, at a right angle with the first ligature.

I carried out these ligations in a number of cases, a series of nine dogs. In some I ligated only arteries, in others also veins. In all—as well as in a guinea-pig—I made exact measurements of the spleen before the ligation, for the results previously obtained with the guinea-pigs operated on (Nos. 10–12) spoke in favor of the possibility that diminished blood supply and nutrition might bring about a general reduction of the organ without producing an infarct.⁹ The ligatures I arranged so that I could not see any transverse branches lying distal to them or—and this latter was as a rule much more simply and quickly done—after ligation of, say, the lower half of the spleen hilum, I drew (Cases 20–22), with the aneurism needle, another ligature from the same point of departure, the centre of the hilum, straight out in the direction of and quite close to the concave surface of the spleen. The results of these operations were much nearer what I wanted than had been the case in the first series.

It may not be out of place here to touch upon the anatomical relations of the vessels *within* the spleen. *A priori* it would be quite conceivable that they might govern the manner in which the organ would react on shutting off a part of the circulation.

The finer structure of the splenic vascular system has for a long time been the subject of active study and discussion. The point in dispute, essentially, is the manner of the connection of the most diminutive arteries with the most diminutive veins: whether the thing takes place directly, by means of a closed system of tubes, as is usually the case elsewhere in the body, or whether it makes use of the intermediation of a system of lacunæ between the arteries and veins. The latter, if it exists, would in the minds of most investigators lack an at least uninterrupted wall, and consequently grant the blood the possibility of flowing out freely from the arterial capillaries into the splenic pulp before it accumulates in the smallest vein branches. Owing to the nature of the walls of the vessels, the blood would then be able to pick its way through the entire cellular structure of the spleen pulp in the same manner as, according to the picturesque description of Henle, a liquid would through a sand-hill. Very weighty reasons have been advanced in the last few years, in support of the view that the blood, on its way through the spleen, does not need to make use of any intermediary lacunæ, but continues proceeding from vessel to vessel, within vascular walls that form an uninterrupted connected whole, which nevertheless are so constructed that both red and white corpuscles are enabled to pass through them, by the process of diapedesis (Helly, Mollier, etc.; see also Weidenreich).

⁹The measurements were taken by placing a linen thread along the surface of the spleen, thus enabling me to obtain a precise value of the size of the entire organ in various directions.

The adherents of one view as well as those of the other are accustomed to base their opinions on now injection experiments, now a direct study of microscopical sections. But there are very slight prospects that either of these methods will ever show how an arterial capillary in the spleen ends, and how a venal capillary begins.

The method I have adopted to get at the answer to this problem is to *reverse the circulation* and then to judge from the microscopical sections whether the blood in the spleen circulates through an open or closed system. I proceeded, in the case of a dog, by applying Carrel's vessel clamps, and then severing one of the spleen's main arteries and one of its main veins. Then, by means of vessel suture, or with Crile's transfusion clamp, I united the proximal end of the artery with the distal end of the vein, and the proximal end of the vein with the distal end of the artery. After a period of 24 hours, at a relaparotomy, there was no noteworthy change in the macroscopical appearance of the spleen. Microscopically, on the other hand, it was quite clear that, in that portion of the organ which corresponded to the vessels affected, the tissue was remarkably full of red blood-cells. With the exception of the follicles (Malpighian bodies) which looked normal, the field was swarming with red blood-cells and very scarce of pulp tissue. Between the "operation area" of the spleen and its normal portion, there was a transition zone in which the frequency of blood-cells was not so pronounced. I shall not here enter into any further interpretation of these sections, as they cannot be considered as in any way representing a finished investigation. Yet it seems to me that they are fully compatible—and most compatible—with the assumption of a system of closed tubes in the spleen, in which the walls of the vessels in the finer branches on the venous side are more easily passed through than on the arterial side, so that, in the former part, under the influence of the more energetic blood current, it permits the passage of the blood-corpuscles to an unlimited number, spreads the Malpighian bodies to a greater distance from each other than obtains usually and fills the spleen pulp with red cells. The great frequency of blood-corpuscles even in the arteries belonging to the Malpighian bodies may be an indication of the presence of vessel walls all over, may be of very slight resistance. If the "reversed blood" from the vein branches reached very soon intermediary wall-less lacunæ, it could hardly have succeeded in getting so far back, *i.e.*, so far into the arterial side, that even the arteries of the follicles became full of red blood-corpuscles.

After this digression, I return to the cases operated on by me (Nos. 13-22), where the ligation of vessels gave a more positive result than I had previously obtained.

Post-operative peritoneal infection did not in this series occur, but two dogs (Nos. 14 and 21) died suddenly a short time after the operation, exactly as had been the case in the first series studied. The first dog (No. 14) presented a rather bad general condition before the operation. He died on the fifth day. No other organic change could be observed than the infarction in the spleen. The other dog who died (No. 21) was a rather large animal in fairly good general condition before the operation. He died three days after four-fifths of

his spleen hilum had been ligated, and on post-mortem examination showed no other abnormality than infarction of a large section of the spleen (Fig. 6). In these cases death may have been due to an intoxication produced by decomposition products of the spleen. Considering the cases together with the manner in which the guinea-pigs operated on reacted—including the two (Nos. 12 and 13) in whom the entire spleen had been disabled, none of them showed any effect on their general condition—we are obliged to note that various species of animals do not bear equally well such a trauma as is involved in the ligation of the vessels above indicated.

As for the changes produced in the spleen itself in the second series of operations, they consisted of an infarction of a greater or less portion of the organ (Cases 14–18, 20, 21), or in a simple reduction of the volume of the spleen without demonstrable infarcts (Cases 13, 19, 22). Most striking was the effect in Case 16: Before operation the length of the spleen was 13 cm., breadth 4 cm., circumference 6 cm.; 33 days after the upper half of the hilum had been ligated, the corresponding dimensions were, 7.4, 3.2, and 6.1 cm. respectively, and the upper pole of the spleen had been reduced to a pale, shrunken infarct, 6 mm. long and 3 mm. deep (Fig. 7).

From a pathological-anatomical view-point the infarcts are very interesting, which, including both series of operations, were produced in ten cases by ligation of a greater or less number of splenic vessels. They represent, taken together, a series of changes more or less pronounced, depending upon the length of time elapsing between the ligation and the animal's death. The age of the changes was from 10 minutes to 45 days.

Even gross-pathologically, it was easy to recognize those parts of the spleen which had been deprived of their normal blood circulations. They had the characteristic appearance of hemorrhagic infarcts: a wedge-shaped area on cross-section, with clear demarcations from the rest of the organ, with, after 10 minutes, a perceptible elevation and of bluish-black color (Fig. 5). Most often (Cases 8, 9, 14, 15, 17, 20, 21) they were multiple; in only two animals were they single (Cases 5 and 16). In five cases (8, 14, 15, 18, 21) there was noticeable a localization of the infarcts to the edges of the spleen (Fig. 5), or, chiefly to one pole or to both poles (Fig. 6). In four cases only one-half of the organ was affected, but in such a manner that the infarct (Cases 5 and 16, Fig. 7) or the infarcts (Cases 17 and 20, Fig. 7) extended over the entire cross-section, and did not limit themselves to the zones along the edges. The formation of infarcts in the centre

of the spleen with the periphery uninfluenced never came to my notice; in the two cases (Nos. 1 and 2) in which the spleen hilum was ligated in the centre, no effect at all was apparent.

It should, however, be noted that this negative result is stated for the condition several weeks after the operation; the effect may have had a different appearance earlier in the process. If a considerable part of the spleen's blood supply or discharge is suddenly cut off, the immediate effect will be a more or less pronounced (depending on the case) alteration in the corresponding tissue and its appearance. In Cases 14 and 21 (Fig. 6) there was recorded, even on the fifth (or fourth, respectively) day after the ligation of the vessels, a noticeable increase in the volume of the organ,^b because of the increase in its blood content, congestion, infarction. A similar enlargement, not, however, one that was measured precisely, was observed in Case 9 five hours, and in Case 15 two hours after the operation. A few minutes after the ligation Case 9 showed multiple small protuberances on the convex surface, but five hours later, on the animal's death, the serous surface was entirely smooth and a general infarction of the organ had begun. Thus a certain adjustment of even rather extensive disturbances of the circulation can, it seems, in various ways be accomplished in due time. And it is not certain that if the animal in question had lived longer, a regular infarct formation would have developed in all the cases which showed infarcted portions at the post-mortem shortly after the vessel ligation. Case 22 gives further strength to this statement. Here, a few minutes after the ligation, there was observed a bluish-black color of the upper half of the spleen, which was in sharp contrast to the lower half of normal coloring. But when the animal was killed, four weeks after, no trace of an infarction could be found; there was merely a distinct reduction in the volume of the entire spleen.

As for the gross-pathological picture of the infarcts thus produced, it is noteworthy, finally, that an anæmic infarct could not be positively detected in any case. In, for instance, Case 18 (in which only the arteries were ligated) the macroscopic appearance of the infarction had a hemorrhagic color still a month later. From the microscopical picture it was not evident in a single case that an anæmic infarct had been produced. This, in view of what the experience shows as to human beings—but we most likely do not have many opportunities to see very fresh human infarcts—arouses our astonishment, though it agrees

^b All these measurements were undertaken in exactly the same manner and under entirely uniform conditions, for which reason I regard it as quite proper to speak of the dimensions comparatively.

LIGATION OF SPLENIC VESSELS

entirely with the earlier experimental results (Karsner and Austin, 1911, who produced infarction in the spleen and kidneys of dogs by introducing a number of plant seeds into the abdominal aorta). The growing pale of the infarct occurs sometimes earlier and sometimes later than the subsiding of its peripheral surface: in Case 17, ten days after the ligation, the infarcts were pale but not depressed; in Case 5, on the fourteenth day the color was hemorrhagic but the serous surface was retracted. Older infarcts had a depressed peritoneal surface (for example, Case 18).

Under the microscope it is easy to distinguish the effect of the circulatory disturbance in the spleen, both with regard to the blood accumulated and to the tissues of the spleen itself.

Already a short time (ten minutes) after stopping the circulation, there is a noticeable enormous oversupply of red blood-corpuscles (Case 8, Fig. 8). The spleen cells are much more attenuated than usual, particularly in a zone immediately under the organ's capsule of connective tissue. This hemorrhagic tissue is not so sharply contrasted with its surroundings as the macroscopically noticeable prominences on its serous surface might lead one to suppose, but merges very gradually into the tissue of normal blood content. Everywhere pigment is found very abundantly, both intra- and extra-cellularly, and often arranged in a thin wreath corresponding to the periphery of the smaller vessels (of the capillary vein?). The Malpighian bodies are in no place saturated with blood, nor in any way altered, nor are the trabeculæ.

After two hours, still more after five hours, it becomes emphatically evident that the frequency of blood-cells is much greater in the periphery than in the central portions (Cases 15 and 9). Certain spots do, however, present a thin zone of more normal spleen tissue, adjacent to the capsule. The outlines of the red blood-corpuscles begin to merge together and are difficult to distinguish. The follicles are no longer entirely free, but show, in various places near the periphery of the spleen, that the cells are pushed apart by red blood-corpuscles.

When the infarct is three days old, it has the appearance of an eosinophilic, structureless, almost hyaline mass, in which there are scattered a small number of well-stained cell nuclei, and also a number of poorly colored ones, as well as some fragments of nuclei (Case 21). The Malpighian bodies also show poorer coloring than usual, and the trabeculæ have in some spots been necrotized. This structureless area contrasts sharply with the adjacent spleen tissue, which is otherwise normal, but full of blood; the line of demarcation itself is made up of a thin—reactive—zone, rich in cells. All these alterations, however,

are not very pronounced at so early an epoch in the case of a small infarct. The contours of the blood-corpuscles are, to be sure, disappeared even in such cases, but the necrosis is not so far advanced. The blood pigment seems nicely placed in the protoplasm of the pulp cells. In Case 14, four days old infarction, also with minor infarcts, a considerable number of red blood-cells have retained their contours. Besides it is noticeable here that the lymphocytes, in this pathological process, are the cells that offer the most resistance to necrosis, and that a comparatively unaffected spleen tissue may continue to be present in a narrow zone close to the spleen's capsule.

In the next following stage, represented in my series of infarcts—the tenth day, Case 17—infarction has already passed beyond its climax. No grouping into follicles is any longer to be detected. Necrosis and karyorrhexis are as pronounced in the periphery as they are at the centre. Regressive processes appear within the infarct, and, at the same time, reactive processes from the adjacent parts are distinctly seen in the form of tissue, connected with the trabeculæ, and rich in cells and vessels. Areas are still found which by their eosinophilic nature indicate the presence, formerly, of red blood-corpuscles, but otherwise one has a predominant impression that most of the blood has been reabsorbed. In Case 5, a case with a very small infarct, four days later the destructive processes were decidedly less apparent than in the case described above.

The next stages I had occasion to study represented infarcts that were macroscopically shrunk and organized, $4\frac{1}{2}$ weeks old. In two cases (Nos. 16 and 18, Fig. 10) I had the picture of connective tissue rich in vessels, and to a great extent sclerotic, and containing pigment within the cells as well as outside of them. The spleen's capsule was thickened and it did not run along in a straight line, but was wrinkled, apparently a consequence of the general reduction in the volume of the spleen brought about by the falling away of the specific spleen tissue. Very often, though, there was found, right under the capsule, a thin layer of common spleen tissue, rich in blood, before getting to the infarcts proper. In a third case of about same age (No. 20, Fig. 9), not all of the necrotic tissue had been reabsorbed, a rather considerable part of it remained in the shape of a central, hyaline, eosinophilic mass, at the periphery of which there began a reaction zone rich in cells and pigment.

It has already been remarked that the ligation of spleen vessels in two dogs operated on (Cases 19 and 22), as well as in all the guinea-pigs operated (Cases 10–13), did not produce any noticeable infarcts

LIGATION OF SPLENIC VESSELS

after 1 to 1½ months, but rather a general reduction of the spleen's volume (to what extent such an effect was present in the dogs lacking infarct in the first series of operations cannot be determined, as I then did not make any precise measurements of the spleen). It has likewise been pointed out above that the anatomical reasons for this effect are to be found in the extensive anastomoses between the vessels in the hilum. Macroscopically, the diminution of the organ was not so great in the case of one (No. 19) of the dogs as in that of the other (No. 22), in which the length of the spleen had in four weeks been decreased by one-fourth of the original dimension. But for both of these cases the microscopic examination gave the impression of a diminished ratio of specific spleen tissue as opposed to connective tissue; necrosis could not be detected. In the guinea-pigs it was of interest (Cases 10 to 13) to note that a very considerable diminution of the organ had begun in spite of the fact that simultaneously the entire spleen had been enveloped in adherent omentum—showing that a subsidiary collateral circulation through the spleen capsule could not be developed and thus compensate the stoppage of the blood supply through the spleen hilum.

It would be no doubt valuable to conduct a long series of operations in which the ligatures should be intentionally so placed as to prevent the formation of infarcts, that is, without making the provisions recommended above, with regard to the transverse anastomosis between the vessels. It is not improbable that it might turn out that cutting off a considerable portion of the spleen's blood-vessels leads to a general, permanent reduction of the volume of the organ, without any infarct intervening. In that case this effect—so far as the conditions may be predicated of man—must seem more ideal than the direct production of infarcts, for the risk of secondary infection of the necrotizing infarcts here disappears. Yet there was not a trace to be found of any such infection in the spleen-operated animals whom I infected intravenously with pus bacteria (Cases 4, 5 and 17); this seems to indicate that spleen infarcts in dogs are not especially susceptible to infection. Besides it may be accepted for the present, that the rich supply of vessels in the individual cases, in the spleen, may make the projected anatomical reduction of the spleen tissue somewhat uncertain and difficult to previously calculate.

My earliest spleen operations I arranged so that I might if possible get some points on the influence of the stoppages on the functioning of the spleen. Various circumstances later prevented me from continuing in this intention. In the first place, I found contradictory results even in the very first counts of blood-corpuscles. ~~Most of the animals did~~

give evidence of a larger supply of red blood-cells in the blood drawn directly from the spleen (*vena lienalis*), than in that found in the general circulation (ear vein) and in the vessels supplying the spleen (*arteria lienalis*) (Cases 1, 2, 4, 5 and 7). But in a few exceptional cases the opposite was true (Cases 3 and 6). The differences in the number of blood-corpuscles in *vena* and *arteria lienalis* were, furthermore, in some cases mighty small.⁴ The prospects of obtaining any conclusions from a comparison between these first differences and those that I might have obtained by counting the blood-corpuscles a few months after the formation of infarcts, were consequently very slight. All the more so since, at this later epoch, the differences, depending on the extent to which the spleen had been infarcted, would have been less than the counts before the operations. To be sure it was also the negative result with regard to the infarct in the spleen, obtained from the animals first killed, that influenced me in giving up the blood-corpuscle counts entirely. It is yet not impossible that the accomplishment of a long series of operations and blood counts might give data of value, not only as to the formation of lymphocytes, but also on that of other blood-cells in the spleen. It would be important, in this connection, in view of the active anastomosis of the splenic vessels with the *vasa gastro-epiploica*, to make sure that such veins in the hilum be chosen as conduct, as far as possible, only blood from the spleen.

The task I had put before me in undertaking ligation of splenic vessels was to find out whether such an operation was an advisable substitute for splenectomy in certain blood diseases. The necessary conditions for its advisability would be, on the one hand, that a simple ligation should, in the case of the individuals concerned, bring about a rather considerable reduction of the spleen, anatomically and physiologically, and, correspondingly, an improvement in the patient's condition; on the other hand, that this should be obtainable at a slighter risk to the latter than is the case in splenectomy.

My investigations, ignoring for the present what they have taught me concerning the arrangement of the vessels in the spleen hilum and concerning the pathology of infarcts of the spleen, have shown that the cutting off of the spleen vessels in the case of the animals in question in a short time led to an anatomical reduction of the spleen specific

⁴ Still more inconclusive were the differences with regard to the number of white blood-corpuscles. Their number alternated, for the nine animals first operated on, between 11,000 and 30,000. Differential counts gave a figure of at most 18 per cent. of mononuclears (about 300 to 450 leucocytes were counted in each case).

LIGATION OF SPLENIC VESSELS

tissue. It is very likely that it also involves a reduction in the work of the organ. In other words, the effect of it may be qualitatively, but not quantitatively, equivalent to the effect of extirpating the spleen. As for the risk of a simple ligation of vessels, I have been able, in the animals I studied, to determine that the dangers of secondary infection from infarcts arising after ligation are at least not great, not even in the pyogenic condition.

In view of the high operative mortality of splenectomy, as well as of its impracticability in certain cases which have perisplenitis and adhesions, it may therefore be very reasonable to ask whether such stoppage should not be resorted to in pernicious anæmia and morbus Banti. The results I obtained concerning its effect are not applicable without further question to sick human patients. What its effect will be in such cases can only be determined by clinical experience. If favorable, it is possible that the advantages of this operation over splenectomy may not lie only in its applicability to inextirpable spleens. Its simpler technic—and presumably, therefore, its lower mortality in operation—might extend the operative indications in the case of the blood affections mentioned. For by having acquired an operative method that would grant temporary relief—and that is about all splenectomy has frequently done in these cases—we also have secured the prospect that a rather large number of patients suffering from chronic anæmias, whose complete cure has thus far been not attainable by our present therapeutic methods, may be successfully treated.

NOTE.—The substance of the above essay was communicated on February 19, 1915, to the regular weekly staff-meeting of the Department of Pathology of Columbia University; the number of the *Journal of American Medical Association* that appeared two weeks later, contained an article by Roblee on "Splenectomy in Primary Pernicious Anæmia" (March 9, 1915). Here it is stated that the ligation of the spleen vessels as a substitute for splenectomy has already been tried on six patients, but with a mortality of 66 per cent. However, the reference to authority is not given, and I have not been able to find in any of the authors cited (A. R. Steele, Harris, and Hertzog—except W. Mayo, on whose advice in the same periodical, in 1910, this mode of operation was tried) any original work such as was indicated.¹ I am therefore not acquainted with the details of these cases. It is surely not unimportant how great a portion of the spleen hilum was cut off, and less

¹I have gone through the "Index Medicus" as well as the *Jour. of the Amer. Med. Ass.* from 1910 to 1914. Possibly Roblee's remark is based on some verbal statement of the operator in question.

so, whether not only the arteries, but also the corresponding veins were ligated. The difference in sensitiveness shown in my experiments on animals, as between guinea-pig and dog, may find a parallel in the similar relation between dog and man, in other words, man may be more vulnerable to such interferences than the dog, as the dog is more vulnerable than the guinea-pig. It should not be overlooked, that in both the animals in my second operation series (Cases 14 and 21) who died spontaneously, both the supplying and discharging vessels had been ligated. In the producing of an infarct it is of no advantage to ligate veins also, but for the removal of the decomposition products of the infarct, it is more desirable to afford as good an egress for the latter as possible, it means to ligate only a few of the spleen's arteries and none of its veins.

LITERATURE

- ¹ Banti: *Fol. hæmatol.*, 10, 1910, p. 33.
- ² Bircher: *Deutsche Zeit. f. Chir.*, 92, 1908, p. 323.
- ³ Coenen: *Beitr. z. kl. Chir.*, 70, 1910, p. 539.
- ⁴ Dahl: *Hygiea*, 76, 1914, p. 473.
- ⁵ Ellenberger u. Baum: *Anatomie des Hundes*, Berlin, 1891.
- ⁶ Fajans: *Beit. path. Anat.*, 57, 1913, p. 282.
- ⁷ Finkelstein: *Roussky Chirourguitschewsky Archiv.*, 25, 1909, p. 327, *Ref. Jour. de Chir.*, 3, 1909, p. 209.
- ⁸ Fischer: *Wien. med. Wochnschr.*, 59, 1909, p. 2506.
- ⁹ Flammar: *Beitr. z. kl. Chir.*, 50, 1909, p. 684, 818.
- ¹⁰ Foà: *Arch. de Sc. méd.*, 1906, 30, and other papers (*cf.* K. Ziegler, *l. c.* p. 628, 676).
- ¹¹ Fowler: *Surg., Gyn. and Obst.*, 11, 1910, p. 133.
- ¹² Girgolaw: *Wratschebnaja Gazeta*, 1909, No. 46-47. *Ref. Zentralbl. f. Chir.*, 37, 1910, p. 255.
- ¹³ Gray: *Anatomy*, 1905.
- ¹⁴ Halsted: *Johns Hopk. Hosp. Bull.*, 25, 1914, p. 223.
- ¹⁵ Hedenius: *Svenska läkaresällskapets handlingar*, 40, 1914, p. 258.
- ¹⁶ Helly: *Arch. f. mikro. Anat.*, 59, 1901, p. 93; 61, 1903, p. 245.
- ¹⁷ Henle: *Anatomie des Menschen*, 1880, p. 197.
- ¹⁸ Hill: *St. Barth. Hosp. Rev.*, 45, 1909, p. 43.
- ¹⁹ Hoerz: *Beit. z. kl. Chir.*, 50, 1906, p. 188.
- ²⁰ Johnston: *ANNALS OF SURGERY*, 48, 1908, p. 50.
- ²¹ Karsner and Austin: *Jour. A. M. A.*, 57, 1911, p. 951.
- ²² King: *Arch. Int. Med.*, 14, 1914, p. 145.
- ²³ Kirchner: *Am. Jour. Obst.*, 59, 1909, p. 431.
- ²⁴ Lanz: *Zentralbl. f. Chir.*, 41, 1914, p. 228.
- ²⁵ Levy: *Zentralbl. f. Chir.*, 37, 2, 1910, p. 1577.
- ²⁶ Long: *Nederl. Tijdschr. v. Geneesk.*, 1905. *Ref. Muench. med. Woch.*, 1905, p. 2195.
- ²⁷ Luedke: *Muench. med. Woch.*, 1909, p. 1469.
- ²⁸ Mayo, W. J.: *Jour. A. M. A.*, 54, 1910, p. 14.
- ²⁹ Meyer, A.: *Zentralbl. f. d. Grenz d. med. u. Chir.*, 18, 1914, p. 41.

LIGATION OF SPLENIC VESSELS

- ³⁰ Michelsson, Payr u. Küttner's: *Ergebn. d. Chir. u. Orth.*, 6, 1913, p. 490.
- ³¹ Moffitt: *Am. J. Med. Sci.*, 148, 1914, p. 817.
- ³² Mollier: *Arch. f. mikr. Anat.*, 76, 1910-1911, p. 608.
- ³³ Moynihan and Upcott: *W. W. Keen's Surgery*, 6, 1913, p. 619.
- ³⁴ Mueller, G.: *Diseases of the Dog*, Philadelphia, 1897.
- ³⁵ Pearce, Austin, Krumbhaar a. o.: *Jour. Ex. Med.*, 16-20, 1912-1914.
- ³⁶ Poppert, Wullstein u. Wilms: *Lehrb. d. Chir.*, 2, 1914, p. 54.
- ³⁷ Roblee: *Jour. A. M. A.*, 64, 1915, p. 796.
- ³⁸ Rystedt: *Nord. Med. ark.*, ii, 1914-1915.
- ³⁹ Sheldon: *Am. J. Med. Sci.*, 139, 1910, p. 581.
- ⁴⁰ Stapelmohr: *Hygeia*, 1914.
- ⁴¹ Sutherland and Burghard: *Lancet*, 1910, 2, p. 1819.
- ⁴² Thévenot: *Province med.*, 21, 1910, p. 245.
- ⁴³ Warren: *ANNALS OF SURGERY*, 33, 1901, p. 513.
- ⁴⁴ Weidenreich: *Arch. f. mikro. Anat.*, 58, 1901, p. 247.
- ⁴⁵ Ziegler, K., Payr u. Küttner's: *Ergebn. d. Chir. u. Orth.*, 8, 1914, p. 625.

REPAIR OF SMALL VESICOVAGINAL FISTULA *

BY CHARLES H. MAYO, M.D.

OF ROCHESTER, MINNESOTA

THE fact that vesicovaginal fistulæ are less common than formerly is undoubtedly due to better care given women during childbirth, though the condition is still occasionally seen as the result of prolonged pressure during labor. Another, or a newer, group of cases is the result of accidental or unavoidable injuries in performing hysterectomies.

Vesicovaginal fistula is a most disagreeable and troublesome infirmity because of the constant leakage, the attendant odor, and the local irritation. As seen by the surgeon these openings, large or small, appear to be mechanically easy of closure, yet the experienced operator knows that they are often very difficult to close and that they occasionally require repeated operations. Some of the openings about the ureter and the posterior wall of the bladder with fistula leading to the vagina are best approached by the abdominal route, extraperitoneally if possible, while the large vaginal fistulæ are best repaired by free incision and good exposure, which is often more difficult than it appears.

There are many cases in which the opening is so small as to be found with difficulty. For such and for those with a lumen not exceeding a quarter of an inch the following procedure is recommended which I have successfully employed in a number of cases during the last twenty years. The procedure is so simple and so generally successful that it almost partakes of a "trick" operation. I am personally indebted to the late Dr. Bernays for the principle of the operation, though I am unable to say whether it originated with him (Fig. 1).

Operation.—An incision is made through the vaginal mucosa extending completely around the fistulous opening about a quarter of an inch or less from its margins. The vaginal mucosa is dissected toward the opening, care being taken not to break through at the margin. This makes a little cup or funnel-shaped opening projecting into the vagina. The circular dissection is carried deeper around the fistula, not approaching nearer than one-eighth of an inch to the margin, its depth penetrating to the mucosa of the bladder but not through it. This leaves a little bell or funnel-shaped opening lined with mucous membrane which is connected with the mucosa of the bladder and projects

* Read before the Western Surgical Association, December 17, 1915.



FIG. 1.—*a*, vesicovaginal fistula. *b*, inversion of vesicovaginal fistula.

Fig. 5—4
72

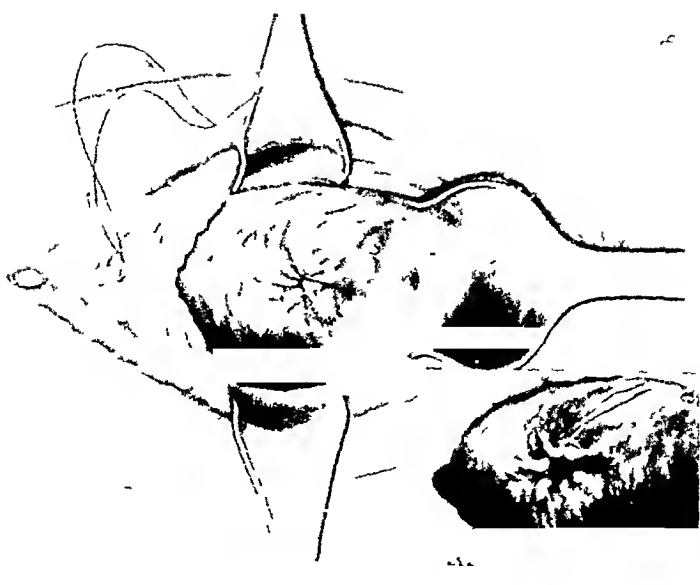


Fig. 5—4, application of purse string b, fistula closed.

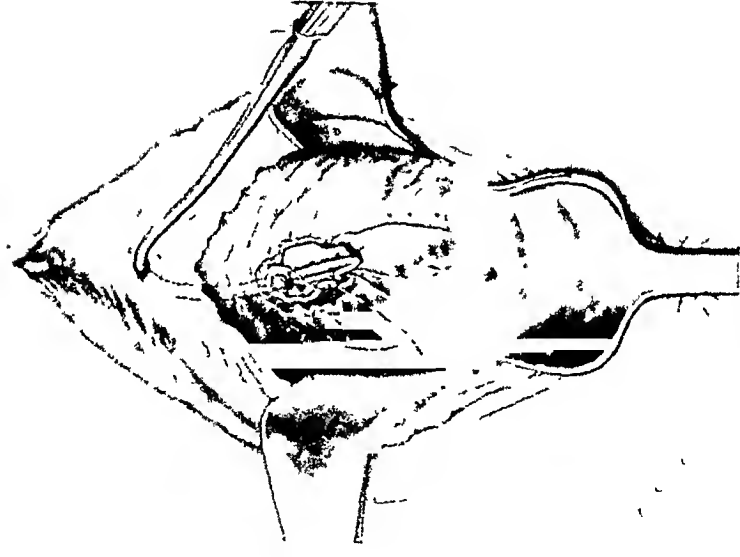


Fig. 3.—Method of inverting fistulous tract by silk sutures.

Fig. 5—4
72

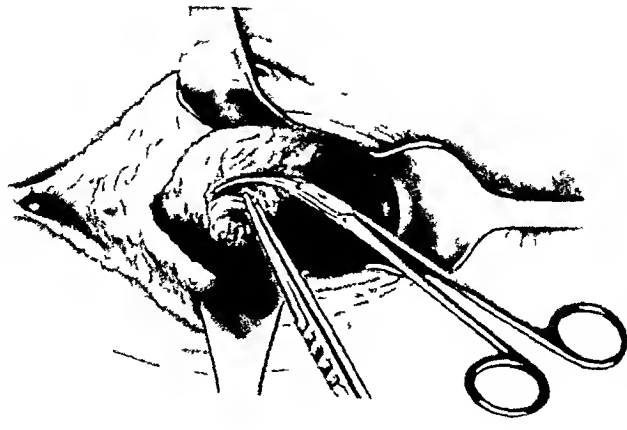


Fig. 2—Separation of vesicovaginal fistula.

REPAIR OF SMALL VESICOVAGINAL FISTULA

into the vagina (Fig. 2). A ligature carrier is passed through the urethra into the bladder and through the fistula into the vagina. A suture is passed through both walls of the funnelled mucosa on each side of the ligature carrier. The two ends of the silk suture are now threaded into the ligature carrier which is withdrawn from the bladder and urethra. The ends of the suture projecting from the urethra are drawn upon, and with a little aid the fistulous tract starts inverting (Fig. 3). As soon as the mucosa disappears a circular suture of fine chromic catgut is applied, a little more traction is used on the ends of the long suture and a second purse-string suture of catgut is applied. The vaginal side is now closed either by a circular suture of the chromic catgut or by interrupted sutures as seems best. This inversion turns the mucous surface into the bladder and leaves a healing surface within the tube. One of the long ends of the suture projecting from the urethra is re-threaded and by a needle is sutured to the skin of the labia. The two ends are now tied at this point, making slight traction. A self-retaining catheter (Pezzer type) is inserted into the bladder and the patient is instructed to rest on her side or even on her face (Fig. 4). This keeps the fistulous area free from urinary pressure. After four days it is necessary carefully to watch the catheter that sediment or phosphatic deposit does not obstruct its lumen. In some cases irrigation is necessary. However, the long suture attached to the inner side of the surface of the fistula and passing through the urethra acts as a safety valve of leakage should the catheter become temporarily plugged. After a week the repair is usually solid, but it is better to keep the patient on her side or face for a few days longer that no undue strain may be placed on the fistulous area, and during this time it is best to keep a catheter in, or if it is removed to have regular periods for passing it. The suture from within the bladder either cuts itself out with the slight traction before it is time to remove the catheter or it may be drawn out without difficulty by cutting one side where it is attached to the skin.

A METHOD FOR OBTAINING UNCONTAMINATED BLOOD FROM DOGS AND OTHER ANIMALS

BY CHARLES GOODMAN, M.D.

OF NEW YORK

PROFESSOR OF CLINICAL SURGERY IN THE NEW YORK UNIVERSITY

(From the Laboratory of Physiological Surgical Research, New York University,
and the Laboratory of Physiological Chemistry, Beth Israel
Hospital)

SEROLOGY has become one of the important features of modern medicine, and is at present receiving close attention from laboratory workers. Our experiments in vascular surgery and transplantation entailed a series of serological studies, and we were confronted at the outset with great difficulties in obtaining specimens of blood from the animals without having them prove worthless for the object of the experiments. This was due to contamination or laking. These obstacles were preëminent in dogs, whose blood coagulates very quickly. On account of the fragility of the erythrocytes in this animal, the blood is handled with difficulty. Peyton Rous at a recent meeting of the Society of Biology and Experimental Medicine stated that he had overcome this inconvenience by the addition of one-eighth of 1 per cent. of gelatin to the specimen. We were unable to make use of this suggestion as it was necessary to utilize serum which was free from foreign substances.

Following the suggestions made by Besson,¹ I had attempted to obtain specimens of dog's blood from the saphenous vein, femoral vessels, the carotid and external jugular. In some instances I obtained specimens from the vein following the margin of the outer side of the ear.

After various efforts with syringes, different cannulas and aspirating needles, I found that blood obtained by a simple glass cannula introduced into the jugular vein gave us the most satisfactory results.

Among the different methods tested was aspiration of the ventricles. This required general anæsthesia in a dog and was attended with great danger to the life of the animal. The following method

¹ Besson, A.: *Practical Biology, Microbiology and Serum Therapy*. Fifth Edition. Translated by H. J. Hutchins. Longmans, Green and Co., Publishers, 1913, London and New York.

OBTAINING UNCONTAMINATED BLOOD FROM ANIMALS

was devised which is exceedingly simple in its application and we wish to report its successful use in 10 consecutive experiments.

Technic.—The dog may be given a preliminary hypodermic of morphine. The external jugular was then exposed under local anæsthesia of novocaine ($\frac{1}{2}$ of 1 per cent.). This anæsthesia was very easily carried out in dogs. Two provisional ligatures were now passed around the vessel for the purpose of controlling the circulation. Two serrefines or flexible blood-vessel forceps might be

FIG. 1.

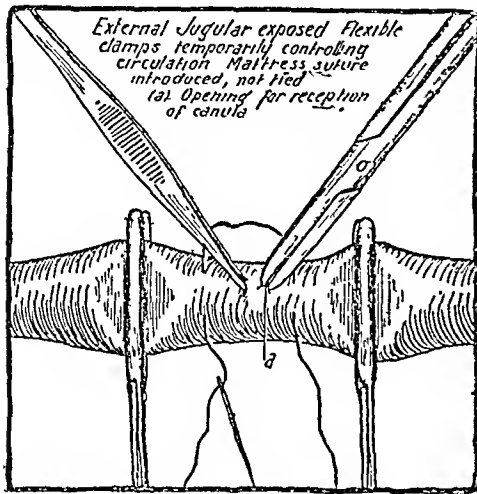


FIG. 2.

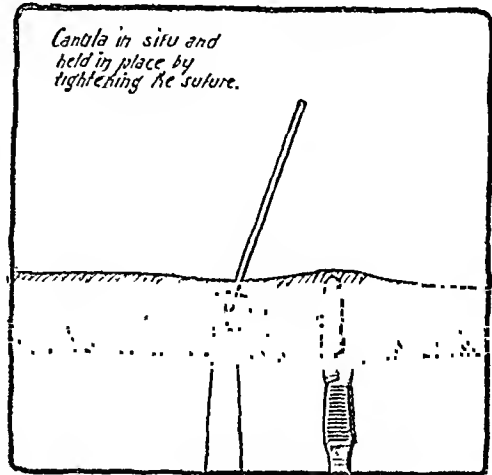
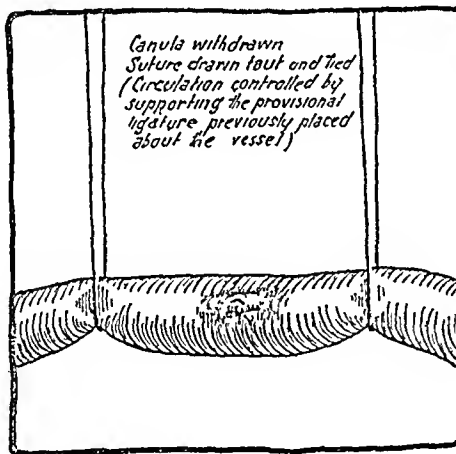


FIG. 3.



employed for the purpose. A square mattress suture of silk threaded on a fine cambric needle was passed through all the coats of the vein. An opening was made in the vein between the two arms of the mattress suture and a small glass cannula previously sterilized was inserted (without paraffin). The suture was now tightened by a slip or bow knot securing the cannula in the vessel. One of the provisional ligatures or serrefines was then relaxed, permitting the blood to flow through the cannula into the sterile test-tube or container. After the desired quantity of blood had been collected, the cannula was withdrawn and the mattress suture was drawn taut and tied. The suture approximated intima to

CHARLES GOODMAN

intima, and the wound healed without thrombosis. This little operation was completed by one or two sutures introduced into the skin. By the use of this method, various quantities of blood were obtained from the same vein at varying intervals without any evidences of thrombosis or interference with the circulation of the vessel. In order to obtain a perfectly clear serum, at the suggestion of Professor A. R. Mandel of the New York University, the tubes containing the blood were immediately placed in a dish of cracked ice. At the end of from 20 to 30 minutes, the plasma was drawn off with a pipette and later the supernatant serum was removed by the same method. The serum obtained was then centrifuged.

By this method invariably large quantities of clear serum were obtained free from corpuscles, bacteria or other contamination.

This method has greatly facilitated the work.

Thanks are due Drs. I. Seff and S. Berkowitz who assisted me in this work.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

Stated Meeting, held October 13, 1915

The President, DR. FREDERIC KAMMERER, in the Chair

BULLET RETAINED IN BRAIN

DR. WALTON MARTIN presented a man, fifty-five years old, who had been referred to him through the kindness of Dr. Abbe.

Thirty years ago, while in Greece, he was shot in the head with a small calibre bullet. He was unconscious for six hours, but subsequently made a good recovery. Eleven years later he began having epileptic fits. He then had an X-ray picture taken which showed the bullet still in his brain. He was referred to Dr. Abbe, who operated on him twice, once in 1900 and once in 1904. The bullet was not removed, but there was a small cyst on the cortex which was opened and an area about the point of entrance of the bullet of adherent dura. He has had no recurrence of the convulsive seizures for the last two years, and is able to work hard as a cook.

Dr. Martin said that he showed him as an example of the tolerance of the brain to a foreign body.

PARTIAL GASTRECTOMY FOR CARCINOMA

DR. MARTIN presented a man, thirty-eight years old, who had been sick for six months with pain in the epigastrium after taking food, and loss of weight. X-ray findings showed a distinct irregularity in contour along the greater curvature, suggesting the possibility of a new growth.

At operation four months ago the middle portion of the stomach was found puckered up by a large carcinomatous mass, extending from the greater to the lesser curvature. A midgastric resection was carried out, the severed ends of the stomach being united by layer sutures of Pagenstecher linen and chromic gut. He made a good recovery and left the hospital on the thirtieth day. The pathological diagnosis was adenocarcinoma of stomach.

The X-ray findings after this midgastric resection show the stomach in this instance to be little deformed and to empty itself fairly well.

In this case, obviously, gastro-enterostomy was out of the question. The operation done had given, at least, the patient a few months of comfortable existence.

DR. JOHN DOUGLAS said that in a great number of cases of carcinoma of the stomach which looked extensive and had lasted for a considerable length of time, it was still possible to do a resection with a very fair chance of permanent relief. He recalled three cases in which he had performed a resection of the stomach, and in each of the cases though palpable glands were present, microscopical examination showed the glands not involved by the carcinoma. In one case the tumor had been present for eighteen months and the patient (a woman) is now alive three years and five months after the operation. In another case, operated upon September, 1912, the symptoms had existed six to seven months and the patient is still living and in good health. In the third case it seemed to be easier to resect the pylorus as well as the middle portion of the stomach. This patient is also alive and well almost three years after operation.

Dr. Douglas concluded that in view of these experiences, although in others recurrences or metastases had occurred, it seemed worth while to take a big chance in these cases of cancer of the stomach rather than do a temporary gastro-enterostomy, for in a fair proportion of the cases a chance of ultimate cure could be obtained.

BULLET WOUND OF KNEE AND OF POPLITEAL VEIN

DR. JAMES H. KENYON presented a man who was admitted to the Hudson Street Hospital, August 14, 1915. A half hour before admission he had been shot twice in the left thigh, in the popliteal space and three inches below the great trochanter. The patient ran a block after the shooting and walked to the hospital.

Examination showed only a moderate amount of hemorrhage from the wound and no appreciable hæmatoma. General condition was good. X-ray plates showed one bullet one-half inch posterior to the mid-line of the femur and about three inches above its lower end. The other bullet was about four inches below the tip of the great trochanter, near the surface.

Although the wound showed no infection, the patient ran a temperature of 100° to 102° for four days. Operation was performed four days after admission; tourniquet applied to middle of thigh, median incision in the popliteal space, with the wound as the midpoint. Opening of the wound revealed the bullet, and was followed by a profuse hemorrhage. Pressure with the finger in the lower part of the wound con-

WOUNDS COMPLICATED BY FOREIGN BODIES

trolled the bleeding which came apparently from the distal part of the vein through a ragged hole through both anterior and posterior walls. The bullet was found immediately behind this opening and was apparently closing it. The bullet was flattened and had probably rebounded from the posterior surface of the femur. The popliteal vein was ligated above and below this punctured wound with plain catgut.

The other bullet was removed from just below the fascia lata. This one was not flattened, but showed on its tip a crucial incision in which a piece of cloth was tightly fastened. The patient stated that he had heard that these individual bullets had been "fixed" for him. The bullet was of 32 calibre.

The patient made an uneventful recovery and left the hospital seventeen days after the operation.

WOUNDS COMPLICATED BY FOREIGN BODIES

DR WALTON MARTIN read a paper with the above title, for which see page 24.

DR. H. H. M. LYLE presented a number of photographs and radiographs taken during his recent stay in the war zone, which illustrated points bearing upon the subject. He laid emphasis on the necessity of a careful inspection of the clothing in order to detect if pieces of cloth, etc., had been carried into the wound and on the necessity of prompt routine X-ray examination of all patients. He called particular attention to the very remarkable fact that there were cases which showed wounds of "entrance and exit," yet the X-ray would reveal the presence of a shrapnel ball. Dr. Lyle stated, although this was absolutely new to him, he had found in searching the literature that Pirogoff had described this phenomenon in 1845 (Fig. 1).

Dr. Lyle said that all foreign bodies, with the possible exception of harmless rifle bullets, should be extracted as soon as circumstances would permit. Shrapnel balls and shell fragments meant imbedded clothes, dirt, straw, etc. In addition to severe primary infection it is interesting to note that cultures taken from old encysted shrapnel balls have shown tetanus bacilli in spite of previous immunization. It seems logical to assume that some of the late unexplained tetanus cases may arise from such sources. These bacteriological findings are a strong argument for the early removal of foreign bodies.

Le Fort has called attention to pseudotetanic complications caused by the presence of foreign bodies near nerve-trunks. These painful spasmodic complications simulating tetanus have in some cases gone

on so far as to threaten the life of the patient. A prompt cure is obtained by localizing and removing the irritating fragments.

Dr. Lyle said there were various methods of locating and removing bullets, shrapnel balls, and shell fragments. The Bergonie vibratory electric magnet is of special value in the removal of shell fragments, but is not applicable to lead shrapnel. The localization is determined by the intensity of the vibration of the tissues over the foreign body. It is not, as the popular belief supposes, an instrument for extraction, but one for localization. Contremoulin's directing needle and the triangulation methods are other excellent means of localization.

At Juilly, Dr. Lyle said they used the Sutton localizing trochar and cannula. Localization by directors, needles, forceps, etc., under the guidance of a fluoroscopic screen has been practised by other men, but Dr. Sutton deserves great credit for developing a simple, safe and efficient technic. The Sutton localizing technic is carried out as follows: The wounded patient is placed on a table beneath which is the X-ray tube and over him parallel to the surface is a movable fluoroscopic screen. Sufficient space is left between the screen and the patient's body to allow of the necessary instrumental manipulations. The room is darkened, the operator waiting until his eyes have become accommodated; as soon as this is accomplished the X-ray is turned on and the site of the entrance of the trochar marked by a puncture incision. The X-ray is switched off, the trochar inserted in the puncture incision, the room again darkened and, when the eye accommodation is adjusted, the X-ray is turned on. The operator now views the field through the fluoroscopic screen and advances the trochar until it impinges on the foreign body. The trochar is withdrawn, a barbed piano wire is passed through the cannula and hooked into the muscular tissue. The cannula is withdrawn and the piano wire left as a guide. The patient is then wheeled to the operating room and the foreign body removed. The advantages of this method are that the time of exposure to X-ray is short, the entire technic is carried out under local anæsthesia, no assistants are required, and no hands come in contact with the instrument, so the operator is free to carry out the necessary manipulations without breaking the aseptic technic (Figs. 2 and 3).

DR. WILLY MEYER called attention to two cases of bullet wound of the brain which he had previously presented before the Surgical Society. The first case was that of a man who had been having the first convulsions six to seven years after an injury to his brain—a pistol-shot wound with no exit. The X-ray proved the presence of the

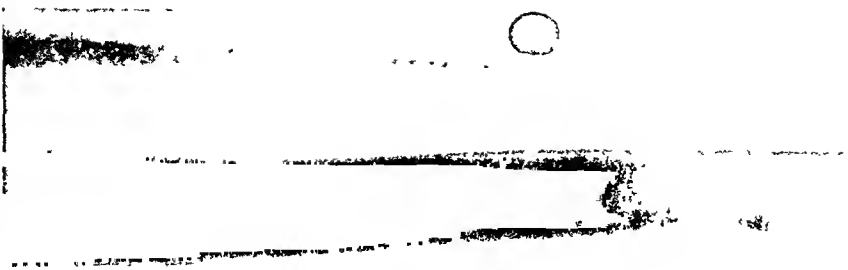


Fig. 1.—Progovt's phenomenon. Penetrating wound of the right leg by shrapnel. Wound of entrance one and a half inches below the tibial tuberosity; apparent wound of exit in the middle third of the calf, postero-external aspect. Ball and clothes removed.

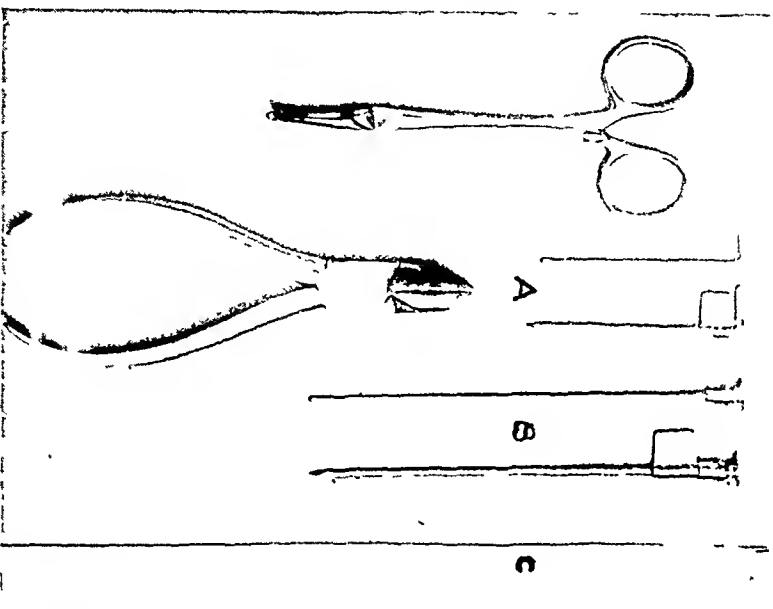


Fig. 2.—A, localizing trochar and cannula; the blunt trochar is used near blood-vessels and nerves. B, original model; the large head interfered with the sighting. C, hooked piano wire which is passed down the cannula and acts as guide in the operation.



Fig. 3.—The Sutton localizing method, showing the relation of patient, X-ray tube, fluoroscope screen, and the trochar and cannula.

WOUNDS COMPLICATED BY FOREIGN BODIES

bullet. The brain was exposed and a large cyst was found, in the depth of which the bullet was located.

The second case was that of a patient who had attempted suicide—a young man who was unfortunate enough to have had both optic and both olfactory nerves traversed by the bullet. He was immediately brought to one of the city hospitals and pulled through as far as his injury was concerned. It was difficult later on to make out the exact situation of the bullet; still, it was pretty well localized with the X-ray to be at the base of the skull. Upon turning down a temporal osteoplastic flap the bullet was found very close to the sella turcica and extracted. The patient made a good recovery and then took an ocean trip, during which he succeeded in jumping overboard.

Dr. Meyer mentioned another case of a patient who was shot in the thigh during the Civil War. There was no exit to the wound at that time. The patient recovered. Twenty years later a large abscess formed over the hip; after a sweeping operation the bullet was not found. Five to six years later he again developed an abscess and again a cause was not found. Six to seven years later he came under the care of Dr. Meyer, fortunately after the introduction of the X-ray. At the time most surgeons were attempting to make radiographs themselves, and Dr. Meyer took an X-ray and found the bullet within the lesser trochanter. Since that time the patient has been entirely well.

Dr. Meyer called attention to the fact that foreign bodies, artificially put in, first healed very nicely and then after years might cause trouble. In illustrating this point, he mentioned the case of a young man upon whom a resection of the knee-joint was done, while he was assistant abroad, where it was customary to perform this operation by placing ivory pegs in to hold the bones in place. The patient was discharged apparently well. Six to seven years later he curiously came under the care of Dr. Meyer in New York for an abscess around the resected knee. On operation it was found that one of the ivory pegs was the cause of the trouble. Dr. Meyer emphasized the point brought out by Dr. Martin, namely, that from a general point of view wounds which were made in order to extract a foreign body had to be regarded as not aseptic; and although in his early practice he closed these wounds tightly by suture, he now felt that it was very important that all these wounds should not be closed entirely, but given a chance to drain.

DR. EUGENE H. POOL mentioned a case which he had shown some years ago before the Surgical Section and which illustrated very well the point brought out by Dr. Martin in regard to the occasional tolerance of tissues to certain foreign bodies. The case was that of a man,

forty-two years old, who came to him with a tumor in the palm of the hand. The patient said that twenty-five years previously he had attempted to remove the shell from a rusty revolver held in the left hand, by hammering a nail with his right hand against the bullet end of the cartridge which was in the chamber. The shell exploded and caused a small punctured wound of the left hand, over the hypothenar eminence. No infection seems to have occurred. A short time later the patient noticed at the site of the wound a movable subcutaneous tumor, about the size of a bean. For six years before admission this tumor had increased in size.

Physical examination, prior to operation, revealed an elongated fluctuating swelling, nine centimetres long by two and a half centimetres broad, extending from one inch above the wrist downward in the middle line to the palm, where it turned gradually to the hypothenar eminence.

The cyst was dissected out. The wall was exactly as described by Dr. Martin: The outer layer of areolar fibrous tissue; a circular layer of very dense hyaline fibrous tissue; third, a layer of dense hyaline material and, fourth, a layer of cells flat and attenuated in the deeper parts and rounded near the inner surface. The contents of the cyst appeared to be composed largely of desquamated cells, also amorphous material, the nature of which could not be determined. Extensive sectioning of the cyst wall failed to show any epithelial elements. The possibility of an implantation cyst was therefore rejected. Within the cyst lay the shell of a .22 long; it was quite black.

The shells of the .22 long are usually composed of 95 per cent. copper and 5 per cent. zinc. The high percentage of copper in the small shells is necessary in order to have the shell sufficiently soft and expansible to fill completely the chamber at the time of discharge to prevent back fire.

DR. ROBERT T. MORRIS called attention to the fact that different structures probably showed different degrees of tolerance. By way of illustration he mentioned the case of a patient whom he operated upon some years ago at the Ithaca Hospital for epilepsy. A year before he was thrown against a buzz-saw which cut through the frontal bone. Upon reaching the dura there was found at operation a piece of felt hat as big as a postage stamp, although the wound had been firmly healed. Dr. Morris ventured the opinion that the felt hat was not sterile; it was, however, walled in so kindly that none suspected the presence of a bit of felt hat, although its influence was responsible for the nervous derangement.

WOUNDS COMPLICATED BY FOREIGN BODIES

In another case in which very extensive adhesions of the dura were separated and a large piece of chromicized Cargile membrane inserted, Dr. Morris had occasion to open the skull some months later for a point of adhesion pain, and found that the Cargile membrane had served very well, but that it was all there, unabsorbed. It apparently had not undergone any change, nor had it caused irritation.

Dr. Morris, in commenting upon the point brought out by Dr. Lyle with regard to a bullet throwing tissue ahead of it, questioned the physics of the mechanism of the injury. He stated that the problem would be simple if one were dealing with hydrostatics, but that here we had elastic tissues and not fluid. The fact remains that tissue may be thrown ahead in that way apparently. In this connection Dr. Morris recalled a case of his in which a bullet partly encircled the chest and an "exit wound" was found, and yet when putting in the drain at that point the bullet was located beneath the skin. Dr. Morris believed that in one of the cases described by Dr. Lyle, some tissue had evidently been thrown ahead and through the skin.

DR. B. J. LEE mentioned a case which he saw about a year ago illustrative of the effects of a foreign body in the abdominal cavity. The patient was a man in the Hudson Street Hospital upon whom a clinical diagnosis of carcinoma had been made. Upon operation a large mass about the size of a fist was found adherent to the posterior abdominal wall high up on the right side, and just below this a smaller mass which was believed to be an involved lymph-node. The smaller mass was removed and sent to the laboratory for examination. Upon looking over the records, it was found that the patient had previously had a laparotomy performed at another hospital. The pathologist found upon examination of this smaller mass a piece of cotton fibre, but upon inquiry of a junior member of the house staff was told that no previous operation had been performed. Upon the pathologist insisting that a previous operation must have been performed, questioning of the patient, who was a foreigner, developed that a previous laparotomy had been done at another hospital. It was therefore evident that the smaller tumor was a foreign-body tumor, suggesting the possibility that the larger mass was possibly also of the same character. The man refused a further exploration to determine this fact and returned to his native land and has therefore been lost sight of.

DR. JOHN DOUGLAS in emphasizing the point brought out with regard to the tolerance of some patients to bullets mentioned the case of a man who had shot himself with a thirty-two calibre revolver just above and back of the ear. The patient was brought to the hospital in

a state of coma, with a bad pulse and an apparent paralysis of the right arm and leg. When he had improved sufficiently to be X-rayed the bullet was located in the left side of the brain, about one and one-half inches from the cortex. At this time the patient was delirious, with incontinence, aphasia and symptoms pointing to a complete right-sided paralysis. In view of this condition the question arose as to whether an attempt to remove the bullet by operation would be justifiable. The concurrent opinion was that death would result in any case, so it was decided to do nothing to the patient. Gradually, however, he began to improve; the incontinence, aphasia, and paralysis of the right leg disappeared, and the power in the forearm began to return. Dr. Douglas stated that when he went off the Prison Ward service of the hospital, six weeks after the admission of the patient to the hospital, the patient was able to leave the hospital and go to Court, the bullet still remaining in the brain.

In illustration of the point regarding bullets frequently not causing infection while clothing will, Dr. Douglas cited the case of a patient upon whom he operated about five or six years ago. The patient was a young man from the Bowery, a prize fighter by profession, who, while travelling about the city in an automobile visiting various primary election booths, was shot at by a rival gang, three bullets hitting him—one in the neck, another in the thigh, and the third entering over the tenth rib on the left side. Upon operation a fracture of the tenth rib was found, and a splinter of the rib had lacerated the spleen, while the bullet had badly lacerated the pelvis of the left kidney. A nephrectomy was performed, the wound in the spleen packed with gauze, and the left pleural cavity through which the bullet had passed drained. None of the bullets were removed. Later the patient was transfused from his brother, and finally left the hospital sufficiently recovered in health to enter the lists for another fight, about a year after his injuries. About three years later, however, he returned to the hospital with a small abscess over the area of the original incision, and a small piece of clothing was found walled in along the line of the original entrance of the bullet. The three bullets remained, however, never causing him any trouble.

DR. MARTIN cited a case of multiple injuries illustrating one of the points referred to by Dr. Lyle. A French soldier was brought to the hospital at Juilly with fifty to sixty small wounds in his face. His eyes and forehead had escaped. These wounds were very small and irregular. Under anæsthesia a small curette passed through the openings in the skin entered in many places a considerable cavity. Particles of

TENDON AND NERVE SUTURE AFTER WRIST WOUNDS

loosened bone and minute fragments of a bullet were removed from many of these wounds. The soldier had been watching intently the German trench opposite him, through a loop-hole, and had apparently been hit by a German bullet which had first struck the sides of the loop-hole and been broken into minute fragments. He himself was firmly convinced that an exploding bullet had caused his injury.

In regard to the origin of late infections occurring about foreign bodies, Dr. Martin stated that there were two possibilities. A few pathogenic organisms of low virulence might be encapsulated with a foreign body and remain latent for years and yet finally cause infection through some additional trauma or lowering of tissue resistance; or the encapsulated foreign bodies might be considered a point of least resistance in the body, where pathogenic micro-organisms entering the blood-stream long afterwards would find conditions favorable for their lodgement and growth. Dr. Martin said he believed the first supposition was correct, as we know that in many instances infection is carried into the tissues by the foreign body.

Stated Meeting, held October 27, 1915

TENDON AND NERVE SUTURE AFTER WRIST WOUNDS

DR. JAMES H. KENYON presented a man, thirty years of age, who was admitted to the Saint Francis Hospital, May 27, 1915, three hours after having cut his left wrist with the edge of a broken bottle.

A temporary dressing and tight bandage to control the hemorrhage had already been applied.

On admission the patient showed loss of sensation and inability to flex the fingers and thumb of the left hand. Examination showed a ragged wound extending completely across the anterior surface of the left wrist, just proximal to the joint.

A two-inch incision was made from the midpoint of this wound upward. All the flexor tendons were found to be completely divided except the one to the little finger, which was partially cut. The median and ulnar nerves were completely severed. Ulnar artery and veins were severed. Each severed tendon was united with one suture of No. 1 iodized catgut; the nerves were united with two sutures of linen placed in the edges of the nerves. Wound closed with catgut sutures, rubber tissue drain. Hand, wrist and fingers put in position of extreme flexion, moulded plaster splint applied on dorsal aspect.

Wound healed by primary union. Passive motion started on the fourteenth day, splint left off on the sixteenth day, massage, manipula-

tion and bathing in warm water and electricity were given frequently for about three months, at which time there was fairly good return of flexion power in the fingers, but to less extent in the thumb; sensation beginning to return; no power in the lumbricales or interossei.

Passive extension showed marked adherence of the scar to the sutured tendons, rendering this motion incomplete and painful. Flexion of the thumb was not as complete as that of the fingers. Because of these conditions a second operation was deemed advisable.

Second operation October 7, 1915, at the New York Hospital. Incision along the radial side of the old scar, which was found to be firmly adherent to the underlying tendons and median nerve. It was dissected free. The median nerve and also the ulnar, but to a less degree, showed a fusiform neuroma about twice the diameter of the nerve at the point of suture. This mass of tissue was dissected away until good nerve bundles were visible. With this tissue the two linen sutures employed at the first operation came away.

The long flexor of the thumb was found to be adherent to the fascia and muscle immediately beneath it, so that contractions of this muscle terminated here instead of producing flexion of the thumb. This tendon was dissected free and wrapped with Cargile membrane, which material was also used to wrap around the nerves. Wound closed with fine silk, without drainage; moulded plaster-of-Paris splint applied, with wrist straight, fingers hyperextended; primary union. Splint removed on the fifth day; active and passive motions begun; sutures removed on the eighth day.

At the present time the fingers can be readily pulled to full extension without pain; flexion of thumb much improved; sensation good. No return of power in lumbricales and interossei, as yet.

The main points to be noticed in this case are that the tendons and nerves were all cut at one level, resulting in all the subsequent sutures being placed at one level. This predisposed to the formation of adhesions between the adjacent structures and the skin, which was still further favored by the immobilization necessary to insure firm union in the divided structures.

The non-absorbable suture material in the nerve structure apparently favored the formation of the neuroma.

DR. H. H. LYLE called attention to the necessity of the proper physiological splinting of the hand and arm and showed photographs of methods of treating gunshot wounds of the nerves, and demonstrated the Tuffier splint for drop-wrist resulting from musculospiral paralysis.

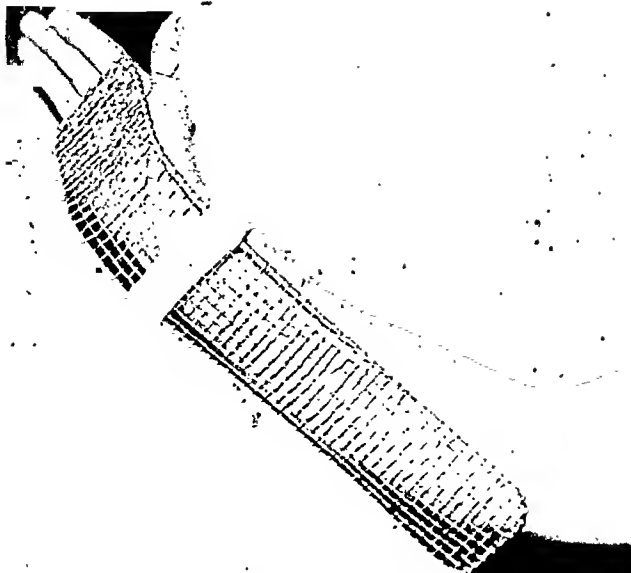


FIG. 1.—Adjustable wire splint for drop wrist.

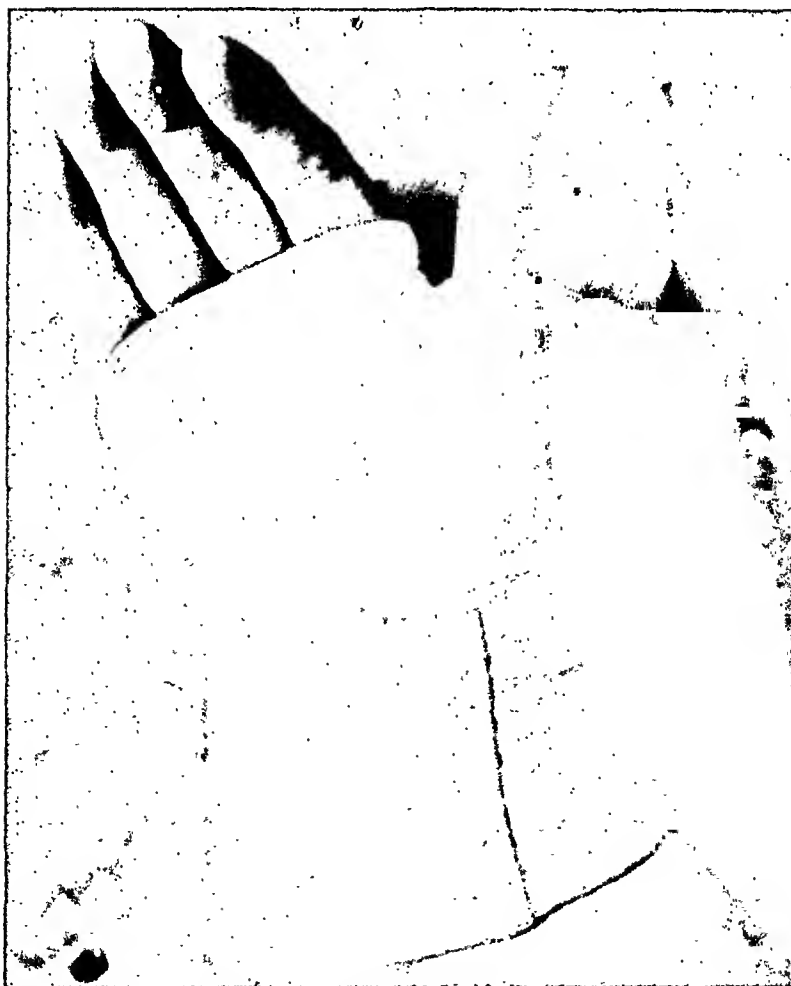


FIG. 2.—Tuffier splint.

TENDON AND NERVE SUTURE AFTER WRIST WOUNDS

Dr. Lyle said that this important principle had not received from the profession the attention it deserved, hardly a text-book on neurology mentioning it. War surgery brings home the extreme gravity of an injury to an important peripheral nerve and the imperative need, whether the nerve is divided or not, of relaxing and protecting the paralyzed muscles from strain by a suitable apparatus. Unrelieved overstretched muscular tissue leads to fatty degeneration and consequent loss of contractility. Many brilliant technical operations have given disappointing functional results. The operator besides contending with the uncertainties of nerve suture has had to correct accompanying deformities and struggle against muscular degeneration. Such complications are preventable and should not occur.

In musculospiral paralysis he used an adjustable wire splint (Fig. 1) to hyperextend the hand, the thumb being abducted and the arm supinated. The hyperextension counteracts the continuous effect of gravity, relaxes the paralyzed extensors, and stretches the flexors, thus restoring the muscular balances and preventing the occurrence of a contracted drop-wrist.

The splint extended from the finger tips to the lower third of the forearm and was secured at the tendinous position of the wrist, care being taken to avoid pressure on the paralyzed muscles. As the patient improved the splint was shortened to the bases of the first phalanges. Later the Tuffier splint (Fig. 2) may be used. This is essentially an aluminum plate exactly moulded to the hand, lined with chamois and kept in place by a lacing over the back of the wrist.

In ulnar injuries the fingers were spread apart, the thumb adducted, the first phalanges flexed, the second and third extended. In median injuries the hand and fingers were strongly flexed; the thumb abducted and flexed, the arm slightly rotated. In circumflex injuries abduction of the arm was the treatment; injury to external popliteal, strong dorsal flexion with eversion.

In reply to a question as to the time of operation, Dr. Lyle said primary suture of a divided nerve is the ideal treatment but is rarely possible in war. The necessity of such an operation presupposes an anatomical division of the nerve, but there is no sure method of immediately differentiating between anatomical and physiological blocking of nerve impulses. This failure to recognize the impossibility of distinguishing between a division, a contusion and a concussion of a nerve has led to many unnecessary and harmful operations. Even if it were possible to make a diagnosis, operation is absolutely contra-indicated,

as all projectile wounds are potentially infected, and to operate in the face of infection is to court disaster. For these reasons it is best to treat all peripheral nerve lesions on an expectant plan, postponing suture until the wounds are healed. In dealing with this class of wounds Dr. Lyle said that it must be kept in mind that one is not dealing with a simple nerve but with a nerve lesion complicated by comminuted bone, torn muscles, inflammatory exudate, etc.; the whole tending to form obstinate adhesions. These conditions are treated with warm starch baths, massage, muscle kneading and systematic exercises carried out by trained assistants. The galvanic current being a good stimulant to nutrition was used, but compared with the other measures electricity plays but a minor part.

Dr. Lyle said that the postural prophylaxis begins with the reception of the wound and continues after the operation until voluntary motion is restored. A strict adherence to this vital orthopædic principle aids in the diagnosis, hastens recovery, prevents many distressing deformities, and will materially diminish the number of useless limbs.

DR. DOWNES said that some three or four years ago he showed a case before the Society similar to Dr. Kenyon's, where all the flexor tendons and the median and ulnar nerves had been divided. The result was practically perfect. The girl could now play the piano.

SPLENECTOMY FOR VON JAKSCH'S ANÆMIA

DR. EUGENE H. POOL presented a child, aged eighteen months, who was admitted to the New York Hospital on April 14, 1915, with a moderate grade of rickets. She was distinctly anæmic. In addition her spleen was markedly enlarged. The examination of the blood at that time gave the following information: Wassermann reaction negative; red cells, 2,700,000; hæmoglobin, 45 per cent.; color index, 0.83; white cells, 12,000. Differential count: Polynuclears, 47 per cent.; eosinophiles, 2 per cent.; basophiles, 1 per cent.; lymphocytes, 29 per cent.; large mononuclears, 18 per cent.; irritation forms, 3 per cent. For each 100 white cells there were normoblasts, 5; megaloblasts, 7.

The blood picture remained essentially unchanged until the time of her operation. Occasionally a myelocyte was seen, but they were unusual. There was marked anisocytosis and poecilocytosis and polychromatophilia, and many of the red cells contained basophilic granules.

On May 1 her spleen was removed. This was easily and quickly done through a vertical incision through left rectus. There were a few light adhesions to diaphragm. No transfusion was made as in the

SPLENECTOMY FOR VON JAKSCH'S ANÆMIA

case previously reported here. In that case there was a question as to how much the transfusion had to do with the improvement in the blood picture. In this case such a question cannot be raised. The spleen weighed 230 grammes; was $14\frac{1}{2}$ cm. \times $8\frac{1}{2}$ \times $3\frac{1}{2}$ cm.

Immediately she began to show improvement. During the three weeks after the operation her red cells rose to 4,500,000 and hæmoglobin to 60 per cent. Her convalescence was interrupted by an attack of measles, which she survived, however, and she went home in fair condition. She was later sent to the country, where she continued her improvement.

When seen on October 10, five months after her operation, she was looking very well. An examination of a stained smear at that time shows a complete change in the picture. The differential count of 500 cells showed: Polynuclears, 17.2 per cent.; eosinophiles, 6.8 per cent.; basophiles, 0.2 per cent.; small lymphocytes, 55.0 per cent.; large lymphocytes, 14.4 per cent.; large mononuclears, 4.2 per cent.; transitional forms, 1.6 per cent.; irritation forms, 0.6 per cent.; red cells, 6,400,000; hæmoglobin, 52 per cent.

The red cells showed a moderate grade of central pallor and but little aniso- or poecilocytosis. There was no polychromatophilia and no nucleated red cells were seen. Only occasionally did a red cell contain basophilic granules. There was still a moderate grade of leucocytosis; weight, $20\frac{1}{2}$ pounds.

The diagnosis of von Jaksch's anæmia was made on the basis of the leucocyte count, well-marked anæmia, and a large spleen associated with rickets in an infant. This diagnosis was confirmed by the histological examination of the spleen. This organ showed the extreme grade of myeloidization of the pulp with atrophy of the Malpighian bodies, which is generally considered as characteristic of the condition. The picture in every way was similar to that seen in another case (S. K.) previously reported. In addition there was evidence of a high degree of blood regeneration, a reversion to an embryonic function of the spleen.

The case can then be definitely considered as belonging to the group known as infantile pseudoleukæmia described by von Jaksch. Following her splenectomy she improved and has continued her improvement for a period of five months. It is impossible to say, however, what is the significance of the striking change in the blood picture. The percentage of mononuclear cells is much higher than one would expect to find even in an infant and this child was two years old at the time. One can only say that following the removal of the spleen

there was a termination of a characteristic blood picture and a substitution therefor of one which we cannot as yet explain.

Her present weight is 20 pounds, red cells 6,000,000 and hæmoglobin 60 per cent. He was indebted to Dr. Ralph G. Stillman of the New York Hospital for the study and description of the blood in this case.

LEFT-SIDED APPENDICITIS COMPLICATING TRANSPOSITION OF THE VISCERA

DR. H. H. LYLE presented a röntgenogram (Fig. 3) of a case of left-sided appendicitis occurring in a patient with a transposition of the viscera. Dr. Lyle said that the history and physical findings were typical of an acute appendicitis with abscess, the pain, tenderness and mass being on the left side. The heart was found to be on the right side. A diagnosis of left-sided appendicitis and transposition of the viscera was made and later confirmed by operation and X-ray findings. The röntgenograms of the chest showed a complete transposition of the heart to the right side, those of the abdomen a complete transposition of the colon. The cæcum was on the left side, also the major portion of the colon, the splenic flexure was low and only rudimentary (Fig. 3).

The interesting point from an operative stand-point was that the peritoneal cavity was greatly diminished in its diameter at the level of the appendix. Suspecting the possibility of a peritoneal anomaly, the incision was made within one and a half inches of the median line. An incision over the usual site would have entered the retroperitoneal aspect of the cæcum.

In reply to the question of frequency Dr. Lyle said that Dr. LeWald, Director of the X-ray service at St. Luke's Hospital, had had fourteen transposition cases, four of the heart alone and ten complete.

THE SURGICAL ANATOMY OF THE THYROID WITH SPECIAL REFERENCE TO THE PARATHYROID GLANDS

DR. EUGENE H. POOL read a paper with the above title, for which see p. 71.

DR. JOHN ROGERS said that from an operative stand-point, these cases should be divided into two classes: First, the cystic or adenomatous goitres and, second, the exophthalmic or hypertrophied goitres. The second are usually the most vascular and present the greater operative difficulties. The dangers as regards injury to the recurrent laryngeal nerves are greatest in the second group, because of their vascularity and the consequent hemorrhage which obscures the field in the deeper

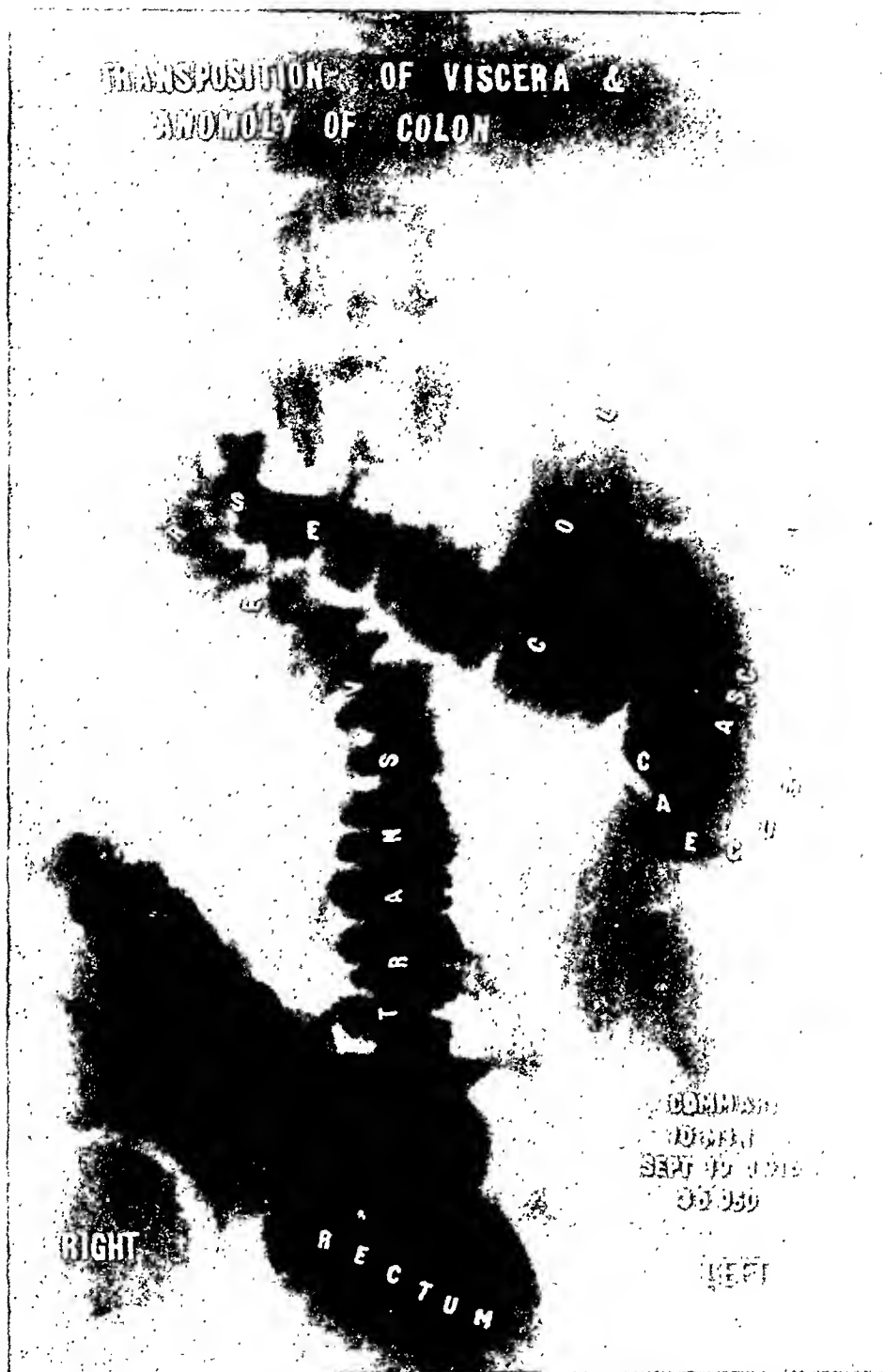


FIG. 3.—Note cæcum on left side. Röntgenogram of chest showed heart on right side. Anomalous condition of transverse colon. (Röntgenogram by Dr. L. T. Le Wald.)

THE PARATHYROID GLANDS

parts of the neck. This leads, unless one is cautious, to the application of clamps or hæmostats to masses of tissue instead of to bleeding points, and the result is not infrequently inclusion of the recurrent nerve. He had had this occur twice in his practice with apparently permanent paralysis. At least, in neither case was there a return of motion one year and one and a half years, respectively, after the operation. In each case he discovered the accident before the wound was closed and traced the nerve through the point of compression, and so proved it had not been cut. In some cases this accident may occur in spite of every precaution. It may, if the hemorrhage is severe and from a torn and retracted artery, be practically unavoidable.

He had never been able in the course of an operation to certainly identify the parathyroid glands. Dr. Pool has excited his admiration by his ability in one case, which he demonstrated a few years ago before this Society, to find a parathyroid and to remove it and then successfully transplant it into another patient showing evidences of post-operative tetany.

DR. CHARLES H. PECK said that he had followed the principle of leaving part of the gland both to protect the parathyroid and to protect the laryngeal nerve. If that is done as a routine, one practically never should lose either parathyroids or injure the laryngeal nerve. He was impressed by Dr. Rogers's remark about the possibility of injuring the laryngeal nerve by clamping. He had an unfortunate experience of that kind in the very first thyroid he had, and he had had a second experience unfortunately this summer in a very tightly-lodged intrathoracic goitre. He left a slice of the posterior capsule and cannot understand even now why he should have injured the nerve, unless he did it in clamping too close or in clamping a nerve that had been dragged forward by dislodging the lobe, which was wrapped pretty well around the trachea. If, however, one follows the principle of dissecting close to the capsule, pretty well down, then entering the capsule and leaving a thin slice of gland, one would very rarely have any trouble either with the nerve or the parathyroid.

DR. FREDERIC KAMMERER said that he could remember only one case of tetany following total extirpation of the thyroid, when that operation was still practised at European clinics before its deleterious effects had been established. This was a little over thirty years ago. Since that time everybody did a one-sided lobectomy and in the rare cases, in which it became necessary to remove part of the other lobe, it was always advisable to cut through the substance of the gland, leaving a shell of thyroid tissue posteriorly, which procedure prevented

exposure of the parathyroids and the recurrent laryngeal nerve. He had had the same experience as Dr. Rogers in trying to demonstrate the parathyroids during operation. He had hardly ever been able to do so, but he had invariably followed the rule, after ligating the superior thyroid vessels and raising the gland towards the median line, to cut through the capsule of the gland and to continue dissection with scissors hugging the glandular substance closely. He now felt, after seeing the instructive cross-sections presented by Dr. Pool, that he had no doubt occasionally removed parathyroids, which in his experience were much more difficult to identify than the recurrent laryngeal nerve, without any untoward symptoms resulting therefrom. The speaker frankly confessed that he had also on several occasions severed the recurrent nerve, but in his cases no permanent injury resulted from this unfortunate occurrence beyond a temporary hoarseness.

DR. POOL said there was no attempt on his part, in presenting this subject, to suggest or to claim any departures from the generally accepted procedures and principles. The object was to demonstrate the relationship of the parathyroids, the surgical capsule and the laryngeal nerve to the posterior part of the lateral lobe. He began the work because he did not know these features himself and could not find them in any article in sufficient detail.

In regard to the case of tetany mentioned by Dr. Kammerer, he thought that case was one too many. One should not see any cases of tetany parathyreopriva.

The statement that an operator, even in a very large experience, has never seen a parathyroid in an operation upon the thyroid is not surprising, when one considers how difficult it is to find a parathyroid in an autopsy specimen. In order to locate a parathyroid in an operation one must look for it carefully in a bloodless field; even then it may be missed.

In regard to the recurrent laryngeal nerve, possibly it may do little harm to cut it on one side, but he had seen a case in which different men had cut a recurrent on each side. As a matter of fact one should not cut one at all.

It is claimed that cutting off its blood supply may produce atrophy of a parathyroid, but it is hard to understand how the same men make this statement and yet encourage transplantation of a parathyroid. Certainly the parathyroid that has not been taken out and simply has its blood supply cut off is better able to live and perhaps functionate than one which is taken from one individual and transplanted into another, or even from the same individual and transplanted into adjacent tissue.

CORRESPONDENCE

CHOLECYSTOSTOMY AND CÆCOSTOMY FOR MERCURY BICHLORIDE POISONING

EDITOR ANNALS OF SURGERY:

In the March number of *Surgery, Gynecology and Obstetrics*, Dr. J. H. Anderson, of Pittsburgh, reports a successful treatment of a bichloride poison case by hydraulic irrigation through a cæcostomy operation performed July 21, 1914. I wish to report briefly for record two cases unsuccessfully treated similarly, one through a cholecystostomy and one through a cæcostomy opening.

The gall-bladder route was suggested to me by Dr. Ellsworth Eliot, Jr., in May, 1913, when I asked his opinion in a rather notorious bichloride case in my practice. In that case operative interference was refused and my first opportunity to try same was in the case that follows:

CASE I.—L.M.J., aged forty plus, male weighing about 160 pounds. Referred to me by Dr. W. C. Pumpelly with history of having dissolved four bichloride tablets in a glass of water and drank same. No emesis for over half an hour. Complete suppression of urine in 12 hours and same persisted on admission to Macon Hospital on December 31, 1914, thirty-one hours after taking poison. Five hours later, 36 hours after taking poison, I drained gall-bladder, opening peritoneum under novocaine and then giving small quantity of gas and oxygen, while handling gall-bladder. Murphy drip with plain water and with sodium bicarbonate instituted after 4 hours. 158, 154, 182, 176, 152, 224 ounces of water were given on successive days. No urine obtained until fourth day when 8 ounces, highly colored and large amount albumen, was obtained through catheter. Urine for next two days voided involuntarily and lost. On seventh day after operation obtained 12 ounces and a good deal was lost. Patient at this time markedly uræmic with general œdema, and died on seventh day after operation, or ninth day after taking poison.

CASE II.—Cæcostomy operation and irrigation through same. Patient referred to me by Dr. A. P. Kemp, of Macon, Ga. Young woman, aged eighteen, admitted to Macon Hospital on September 21, 1915, with history of having taken several ounces of a strong solution of bichloride three hours previous to admission. Customary treatment with emetics and lavage and magnesium

CORRESPONDENCE

sulphate for forty hours when acute suppression of urine commenced. Referred to me twelve hours later when I performed cæcostomy under novocaine, using, as in previous case, small amount of nitrous oxide and oxygen after opening peritoneum. Murphy drip tap water started in few hours, using 178, 448, 288, 224, 240, 310, and 272 ounces of plain tap water on succeeding days. From this she secreted $\frac{1}{2}$, 7, 4, 3, 2, 4 and 1 drachms of urine, dying in uræmic convulsions on seventh day after operation.

My next case I hope to get earlier and to keep in a rectal tube as suggested by Anderson.

CHARLES C. HARROLD, M.D.

Macon, Georgia.

To Contributors and Subscribers:

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N. Y.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS of SURGERY

227-231 S. 6th Street

Philadelphia, Penna.

ANNALS *of* SURGERY

VOL. LXIII

FEBRUARY, 1916

No. 2

STUDIES ON THE LOCALIZATION OF CEREBELLAR TUMORS

THE POSITION OF THE HEAD AND SUBOCCIPITAL DISCOMFORTS

BY ERNEST G. GREY, M.D.

OF BOSTON, MASS.

(From the Surgical Clinic of the Peter Bent Brigham Hospital, Harvard
Medical School)

IN patients with cerebellar and extracerebellar tumors the head is frequently held tilted toward one shoulder. The face may be turned toward the opposite side or directed forward. Often occipital headache or neuralgia, local tenderness, and stiffness of the neck muscles also form striking features of the patients' syndromes. In establishing a differential diagnosis between supra- and infratentorial lesions and drawing conclusions regarding the localization of tumors which appear to involve the cerebellum the question frequently arises as to the proper interpretation of these signs and symptoms. Notwithstanding the comprehensive literature which pertains to diseases of the posterior cranial fossa, the significance of the position of the head and of suboccipital discomfort still remains uncertain.

The object of this study has been to secure information concerning these features in order to appraise correctly their diagnostic importance in the routine examination of such patients. To accomplish this end a series of 60 cases, in which the presence and situation of the lesion have been certified, has been selected from two hundred odd patients with cerebellar or extracerebellar new-growths. In these the clinical observations concerning head posture and suboccipital distress have been correlated with the data subsequently obtained from the operating and post-mortem rooms.

Similar analyses of other so-called cerebellar tumor signs have been discussed elsewhere.^{6, 7, 8}

The records used in this work are from patients who have appeared in the neurological services of Dr. Cushing at the Johns Hopkins Hospital previous to September, 1912, and at the Peter Bent Brigham Hos-

pital since that date. Most of the cases in the latter group were personally studied by the writer. All records have been excluded which showed that the disease had extended into other parts or which included additional factors likely to confuse the symptom-complex.

In addition, for purposes of comparison, the records of 43 patients from the Brigham Hospital Clinic with certified supratentorial tumors have been analyzed for the presence or absence of these signs.

It is difficult in many cases of cerebellar tumor, especially where the growth is extensive, to be certain whether the assumed position of the head is due to the new-growth itself or to pressure on nerve-paths in its immediate neighborhood. For clinical purposes, however, it makes little difference how a tumor affects the posture of the head provided its localization is correlated with the change in attitude which it brings about. It is convenient for purposes of analysis and study to classify cerebellar new-growths according to their situation in the posterior cranial fossa. Such a classification has been adopted here, viz.: Group I—tumors which occupy a part or the whole of one hemisphere; Group II—median tumors which occupy the vermis, or the vermis and equal amounts of both hemispheres; Group III—recess tumors which occupy one cerebellopontine angle; and Group IV—median tumors which lie inferior to the cerebellum.

LITERATURE ON THE POSITION OF THE HEAD

A characteristic attitude of the head in patients with cerebellar new-growths has been described by Batten.¹ Of 6 cases investigated pathologically this position was noted in 3. The head was tilted so that the ear contralateral to the affected cerebellar hemisphere approximated the corresponding shoulder. There was also some rotation of the head, the chin being turned toward the side of the lesion. The fact that Batten discovered this position in some cases in which only internal hydrocephalus was found at necropsy indicates that he did not regard it as pathognomonic of cerebellar disease.

A certified case of cerebellar tumor in which the head was tilted toward the affected hemisphere has since been reported by Larnelle.¹¹

A characteristic inclination of the head to one side was noted by Gordon⁵ in a number of cases which he studied clinically and at necropsy. In several of these the position first assumed appeared reversed at subsequent periods of the disease.

Stewart and Holmes²⁰ found a more or less characteristic attitude in a number of cases of unilateral cerebellar and extracerebellar tumors. While sitting or standing the head was slightly flexed to the side of the

LOCALIZATION OF CEREBELLAR TUMORS

lesion and rotated so that the chin was directed toward the opposite shoulder. As this position was occasionally found reversed and as it was met with in cases with lesions elsewhere in the brain, no important diagnostic or localizing importance was attached to it.

Oppenheim¹⁵ has encountered this sign in a number of patients with cerebellar tumors. Since contractures and paralyzes of the neck muscles are usually absent he believes that the patient holds his head in that position which affords him the greatest relief from his discomforts. This has been Dr. Cushing's view. Any disturbance of postural sense which may exist as a result of the lesion plays a minor rôle. The attitude assumed by the head represents the position of greatest ease. In confirmation of this view he has drawn attention to the frequency with which passive flexion of the neck occasions pain.

Mills and Weisenburg¹³ in their kinematographic studies of asynergia noted a definite attitude of the head in only one case.

v. Beck² and Muck¹⁴ have drawn attention to the changes in intracranial circulation which result from turning the head on its vertical axis. When the chin is approximated to one shoulder the internal jugular vein on this side is compressed, while the opposite one is expanded. In controlling the bleeding from military wounds involving the mastoid region the latter has found this knowledge to be of considerable importance. Both v. Beck and Muck regard such an attitude of the head as characteristic for cerebellar and extracerebellar abscesses. In the presence of such a collection of foreign material more or less relief from headache is afforded by turning the chin to the side opposite to that of the abscess. This hastens the circulation in the homolateral internal jugular vein and accordingly lessens the venous congestion on the diseased side.

Backward retraction of the head, cerebellar fits (tetanus-like seizures), and the so-called cerebellar attitude, due to a gross exaggeration of the extensor muscles of the spine in the presence of tumors of the vermis, were first described by Hughlings Jackson,¹⁰ and since his communication in 1871 similar cases have been reported by others. Horsley⁹ observed opisthotonos attacks in a boy who was subsequently found to have a large new-growth occupying one cerebellar hemisphere. The cerebellar attitude was noted by Buzzard³ in a patient with a lesion confined to both dentate nuclei.

DATA ON THE POSITION ON THE HEAD

I. UNILATERAL HEMISPHERE TUMORS (Twenty-five Cases):

1. *Head Tilted Toward the Side of the Tumor.*—In 5 of the 25 cases in this group it was tilted slightly; in a sixth the attitude was

more marked. One case showed a slight rotation of the head, the chin being directed toward the side contralateral to the tumor.

2. *Head Tilted Away from the Side of the Tumor*.—Of 4 such cases 1 was tilted only slightly. Some turning of the chin toward the side of the tumor was noted in 2 cases.

3. *Head in No Unusual Attitude*.—Fifteen cases showed nothing characteristic about the position of the head.

II. TUMORS INVOLVING THE VERMIS OR THE VERMIS AND EQUAL AMOUNTS OF BOTH HEMISPHERES (Thirteen Cases):

1. *Head Tilted to One Side*.—In 6 of the 13 cases in this group there was some tilt toward one side. Four of these had slight rotation of the chin in the direction opposite to that in which the head was tilted.

2. *Head in No Unusual Position*.—Seven cases showed nothing characteristic.

III. UNILATERAL CEREBELLOPONTINE TUMORS (Seventeen Cases):

1. *Head Tilted Toward the Side of the Tumor*.—Of the 17 cases in this group 3 showed a slight and 1 a more marked tilt of the head toward the side of the tumor. The chin was turned toward the opposite shoulder in 4. In 1 of the latter, however, the head was not tilted in either direction.

2. *Head in No Unusual Attitude*.—There was nothing characteristic about the position of the head in 12 of the 17 cases.

IV. MEDIAN, INFERIOR, EXTRACEREBELLAR TUMORS (Three Cases):

1. *Head Tilted to One Side*.—In 1 of the 3 cases in this group the head was tilted slightly to one side.

2. *Head Tilted Forward*.—One case showed a marked, persisting, forward inclination of the head on the chest.

3. *Head in No Unusual Attitude*.—The head was carried in a normal position in one case.

SUMMARY.—Thus 35 of the 58 cases in which the attitude of the head was studied showed no unusual position of the head. There were 42 cases with unilateral tumors. In 10 the head was tilted toward the lesion; in 4 it was tilted toward the side opposite to the lesion; and in 28 no tilting to either side was noted.

TUMORS LYING ANTERIOR TO THE CEREBELLUM

I. *Unilateral, Solitary, Parietal Lobe Tumors*.—Of 13 cases no characteristic position of the head was noted in any of them.

II. *Unilateral, Solitary, Temporal Lobe Tumors*.—No characteristic attitude of the head was noted in 8 cases.

LOCALIZATION OF CEREBELLAR TUMORS

III. *Unilateral, Solitary, Temporoparietal Tumors*.—One case. The head here was tilted slightly toward the side of the new-growth.

IV. *Unilateral, Solitary, Occipital Lobe Tumors*.—One case. No unusual position of the head noted.

V. *Unilateral, Solitary, Frontal Lobe Tumors*.—Two cases. Neither showed any characteristic attitude of the head.

VI. *Extradural Tumor at Foramen Magnum*.—One case. Head held in no unusual position.

VII. *Pontine New-growths—Solitary*.—Three cases. In 1 the head was tilted slightly to one side with some rotation of the chin toward the opposite shoulder. Two cases showed neither rotation nor tilt.

VIII. *Solitary Tumors Involving Basal Ganglia*.—Three cases. No unusual position was found in 2 of these. One held his head tilted slightly toward the side of the tumor while sitting in a chair. While walking, however, the tilt was in the opposite direction.

IX. *Interpeduncular (Pituitary) New-growths*.—Eleven cases. No characteristic position was noted in any of them.

BACKWARD RETRACTION OF THE HEAD

In a series of 58 cases of cerebellar and extracerebellar tumor there were 8 which showed this symptom. The retraction occurred only during the periods of suboccipital headache in every case. At such times flexion of the neck was painful. Holding the head forward as in writing would precipitate an attack of suboccipital pain in one patient. A ninth obtained relief from suboccipital distress by throwing the head backward. The lesion involved one cerebellar hemisphere in 6 of these, the vermis and one hemisphere in 1, and the cerebellopontine angle in 2. Strange to say, in one subject the greatest relief was afforded by keeping the head flexed forward on the chest. The tumor here involved one lateral lobe.

True opisthotonos attacks have occasionally been observed but they were featured in the histories of two patients. In both the seizures were marked by severe occipital pains, extreme retraction of the head, a backward curving of the spine, and a sense of impending death. Periods of rigidity described by Hughlings Jackson were observed in each subject—in one, enduring frequently for hours. Operation with subsequent necropsy demonstrated an extensive glioma in both. The new-growth involved the vermis and part of the left hemisphere in one and the anterior portions of the vermis and both lateral lobes in the other.

No backward retraction of the head was noted in any of the cases with tumors lying anterior to the cerebellum.

ATROPHY OF THE OCCIPITAL BONE AND LOCAL TENDERNESS

Occipital tenderness in cases with new-growths in the posterior cranial fossa is usually ascribed to atrophy or osteoporosis of the subjacent bone. The data resulting from comparisons of clinical and operative findings in many of the patients reported here, however, have not harmonized satisfactorily with such a view. In order to obtain a more comprehensive idea of the possible bearing of one of these factors on the other a series of cases were selected in which the condition of the occipital bone had been specifically described in the operative note. The relations found in this certified group are indicated by the following analysis.

I. *Unilateral hemisphere tumors* (19 cases) :

Bilateral tenderness with no noteworthy thinning of the occipital bone, 1 case.

Bilateral tenderness with bilateral thinning of the occipital bone, 1 case.

Bilateral tenderness with homolateral (as regards the site of the tumor) thinning, 1 case.

Homolateral tenderness with bilateral thinning of the bone, 1 case.

No tenderness and no thinning of the occipital bone, 7 cases.

No tenderness with bilateral thinning of the occipital bone, 7 cases.

No tenderness with homolateral thinning of the occipital bone, 1 case.

II. *Tumors involving vermis or vermis and equal amounts of both hemispheres* (7 cases) :

Bilateral tenderness with bilateral thinning of the occipital bone, 1 case.

Unilateral tenderness with no thinning of the occipital bone, 1 case.

No tenderness and no thinning of the occipital bone, 2 cases.

No tenderness with bilateral thinning of the occipital bone, 3 cases.

III. *Unilateral cerebellopontine tumors* (13 cases) :

Bilateral tenderness with no thinning of the occipital bone, 3 cases.

Homolateral tenderness with bilateral thinning of the occipital bone, 1 case.

Contralateral tenderness with bilateral, especially homolateral, thinning, 1 case.

No tenderness or thinning of the occipital bone, 5 cases.

No tenderness with bilateral thinning of the occipital bone, 1 case.

No tenderness with unilateral thinning of the occipital bone, 1 case.

IV. *Median, inferior, extracerebellar tumors* (3 cases) :

Unilateral tenderness with no thinning of the occipital bone, 2 cases.

Tenderness and thinning of the occipital bone, 1 case.

LOCALIZATION OF CEREBELLAR TUMORS

LITERATURE ON SUBOCCIPITAL DISCOMFORT

Headache, as is well known, is practically always present at some stage in patients with cerebellar and extracerebellar new-growths, due usually to the fact that secondary internal hydrocephalus appears as an early complication. Redlich,¹⁹ Oppenheim¹⁰ and others found it to be chiefly occipital in such cases. The former noted that it is occasionally more marked on the side of the tumor and may take the form of a severe occipital neuralgia. According to Stewart and Holmes²⁰ the situation of the headache is often suggestive of the seat of the disease.

Stiffness of the neck muscles and pain in one or both sides, when the head is bent forward or turned to either side, frequently accompanies the other discomforts of cerebellar new-growths. The importance of stiffness of the neck in cerebellar abscess and in epidural abscess of the posterior cranial fossa without meningitis has been emphasized by Friedenbergl, Okada¹² and others. Dr. Cushing has found that pain elicited by passively flexing the head is often a valuable diagnostic guide in patients with subtentorial tumors. Like the headache, however, both of these signs may be present with growths situated elsewhere in the brain. Oppenheim¹⁷ observed a stiffness of the neck in cases of frontal lobe tumor. Finkelburg⁴ found stiffness of the neck muscles and pain in the occiput and neck in cases with tumors of the interpeduncular region.

Occipital tenderness has been noted in many cases of cerebellar tumor. Redlich¹⁹ occasionally found a distinct local tenderness on percussion over the side of the tumor. In the cases studied by Stewart and Holmes²⁰ the majority experienced considerable discomfort when pressure was made over this region. Generally it was greater on the side corresponding to the disease. Taken collectively with other features of the history and examination, Dr. Cushing regards tenderness in the suboccipital region as a very suggestive symptom of a subtentorial new-growth. Oppenheim¹⁸ believes that in extracerebellar tumors this sign is of value only where there is considerable increased intracranial pressure with local osteoporosis.

DATA ON SUBOCCIPITAL DISCOMFORTS

I. UNILATERAL HEMISPHERE TUMORS (Twenty-six Cases):

1. *No Suboccipital Discomforts*.—Five of the 26 cases in this group had no suboccipital headache, pain, tenderness or stiffness of the neck muscles.

2. *More Suboccipital Discomfort on the Side of the Tumor*.—Five cases. Three had more tenderness, 4 had more suboccipital headache

or neuralgic pains, and 2 had more stiffness and soreness of the neck muscles (especially on turning the head from side to side) on the side homolateral to the lesion.

3. *More Suboccipital Discomfort on the Side Contralateral to the Tumor.*—Four cases. One had slight tenderness, 2 had more headache and 3 more stiffness or soreness of the neck muscles.

4. *Bilateral Suboccipital Discomfort.*—Twelve cases. Three had some tenderness, nine had some suboccipital headache or pain, and 6 had some stiffness or soreness of the neck muscles—equally marked on the two sides.

II. TUMORS INVOLVING THE VERMIS OR THE VERMIS AND EQUAL AMOUNTS OF BOTH HEMISPHERES (Thirteen Cases):

1. *No Suboccipital Discomfort.*—Five cases. No local tenderness, headache, pain, or stiffness and soreness of the neck muscles.

2. *Unilateral Suboccipital Discomfort.*—Three cases. Two had tenderness, 1 had headaches, and 1 had more stiffness and soreness of the neck muscles (on twisting the head) more marked on one side.

3. *Bilateral Suboccipital Discomfort.*—Five cases. In 3 there was local tenderness; in 4, headaches; and in 1, stiffness of the neck muscles equally marked on the two sides.

III. UNILATERAL CEREBELLOPONTINE TUMORS (Seventeen Cases):

1. *No Suboccipital Discomfort.*—Five cases. No one of these experienced any local tenderness, suboccipital headaches or pain, or stiffness and soreness of the neck muscles.

2. *More Suboccipital Discomfort on the Side of the Tumor.*—Five cases. Two had more tenderness, 5 had more headache or pain on this side, and 1 had more stiffness of the neck muscles.

3. *More Suboccipital Discomfort on the Side Contralateral to the Tumor.*—Two cases. Both had more tenderness and more headaches on this side. One also experienced more stiffness of the contralateral neck muscles.

4. *Bilateral Suboccipital Discomfort.*—Five cases. Three had local pain or headache equally marked on the two sides.

IV. MEDIAN, INFERIOR, EXTRACEREBELLAR TUMORS (Three Cases):

1. *Unilateral Suboccipital Discomfort.*—Two cases. Both of these had local tenderness and stiff neck muscles, and one also complained of headaches, more marked on one side of the occiput.

2. *Bilateral Suboccipital Discomfort.*—One case. Stiffness of the neck muscles and suboccipital pain were equally marked on the two sides.

SUMMARY.—Thus only 15 out of the 59 cases failed to have sub-

LOCALIZATION OF CEREBELLAR TUMORS

occipital discomfort. Forty-three of the 59 had unilateral tumors. Of these 10 had more suboccipital discomfort on the side of the lesion, 6 had more on the contralateral side and 17 experienced equal discomfort on the two sides.

TUMORS LYING ANTERIOR TO THE CEREBELLUM

I. *Unilateral, Solitary, Parietal Lobe Tumors*.—Thirteen cases. Ten of these had no suboccipital discomforts. Two experienced some discomfort on the side homolateral to the tumor. Of the latter both had headache and pain, one had stiffness of the neck muscles and both had suboccipital tenderness.

II. *Unilateral, Solitary, Temporal Lobe Tumors*.—Eight cases. Six had no suboccipital discomfort. Of the 2 which experienced some, 1 had stiffness of the neck, both had local tenderness, and both had some suboccipital headache or pain. The discomfort in these 2 cases was experienced more on the side homolateral to the tumor.

III. *Unilateral, Temporoparietal Tumor*.—One case. There was slight suboccipital tenderness and some suboccipital headache on the side of the new-growth.

IV. *Unilateral, Occipital Lobe Tumor*.—One case. There was slight suboccipital pain and stiffness of the neck muscles on the side of the tumor.

V. *Unilateral, Solitary, Frontal Lobe Tumors*.—Two cases. Neither had suboccipital headaches, pain, tenderness or stiff neck muscles.

VI. *Extradural, New-growth at Foramen Magnum*.—One case. Some bilateral tenderness and stiffness of the neck muscles.

VII. *Pontine New-growths—Solitary*.—Three cases. One had no suboccipital discomforts. Two complained of some, more marked in each case, on one side of the occiput—tenderness and headache.

VIII. *Solitary Tumors Involving the Basal Ganglia*.—Three cases. One had some suboccipital headache, equally marked on the two sides. Two experienced suboccipital discomforts chiefly on the side of the lesion—both from stiffness of the neck muscles, and one from tenderness and headache.

IX. *Interpeduncular (Pituitary) New-growths*.—Eleven cases. One complained of some bilateral suboccipital headache. The other 10 cases experienced no suboccipital discomforts.

SUMMARY AND CONCLUSIONS

Of 58 certified cases of cerebellar and extracerebellar tumor an unusual attitude of the head—tilted so that the ear approximated one

shoulder, or both—was found in 23. In the majority of these the change in position was slight. Of 43 certified cases of tumor lying anterior to the cerebellum only 3 showed any tilt or rotation of the head. The unusual attitude in these 3 cases was scarcely noticeable. About 40 per cent., then, of the cases with cerebellar tumor showed some change in the position of the head while only about 7 per cent. of the cases with tumors anterior to the cerebellum showed any unusual attitude.

These findings indicate that a tilt or rotation of the head in a patient with symptoms pointing toward an intracranial tumor is suggestive of a subtentorial new-growth. Such an attitude, however, has no additional significance in localizing the lesion in one or the other side of the posterior cranial fossa.

Backward retraction of the head was a feature in 8 of the 60 cases of cerebellar and extracerebellar tumor. Typical opisthotonos attacks appeared in 2 of these. A similar position was noted in none of the cases with tumors lying anterior to the cerebellum. Backward retraction of the head, then, is characteristic of new-growths situated below the tentorium:

While atrophy or osteoporosis of the subjacent bone may occasion occipital tenderness in certain cases, comparisons of the clinical and operative findings in this series of cases have shown no consistent relations to exist between the two.

Of 59 certified cases of cerebellar and extracerebellar tumor some form of suboccipital discomfort was present in 44, about 75 per cent. Tenderness in the subocciput was found in 21, 36 per cent. Suboccipital headache or pain was complained of in 33, 56 per cent. There was more or less soreness or stiffness of the neck muscles in 18, nearly 31 per cent. Accordingly, headache or pain is the most frequent of the suboccipital discomforts.

Of 43 certified cases with tumors lying anterior to the cerebellum some degree of suboccipital discomfort was found in 14, approximately 33 per cent. Suboccipital tenderness was present in 8, nearly 19 per cent. Suboccipital headache or pain appeared in 10, about 23 per cent. Soreness or stiffness of the neck muscles was complained of in 6, 14 per cent. As a rule the occipital discomforts were much less intense in the cases with tumors situated anterior to the cerebellum than in those with subtentorial new-growths.

Taking the series as a whole, no consistent relation has been found between the part of the posterior cranial fossa occupied by the tumor and the site of the discomfort. When unilateral suboccipital discomfort

LOCALIZATION OF CEREBELLAR TUMORS

is present, however, it is slightly suggestive of the side of the new-growth.

These findings indicate that suboccipital discomforts are present more than twice as often in patients with subtentorial new-growths as in those with tumors situated elsewhere in the brain; and, though they afford only slight assistance in localizing the lesion in one or the other side of the posterior cranial fossa, they nevertheless rank with asynergy (limb ataxia, staggering gait, etc.) as the most important indications of a subtentorial localization of intracranial new-growths.

REFERENCES

- ¹ Batten: On the Diagnostic Value of the Position of the Head in Cases of Cerebellar Disease. *Brain*, 1903, xxvi, 71.
- ² Beck, v.: See Lossen, Beiträge zur Diagnose und Therapie der Kleinhirnabscesse. *Beitr. z. klin. Chir.*, 1903, xxxix, 814.
- ³ Buzzard: The Cerebellar Attitude and the Dentate Nuclei. *Brain*, 1906, xxix, 508.
- ⁴ Finkelburg: Beiträge zur Symptomatologie und Diagnostik der Gehirntumoren u. s. w. *Deutsch. Ztschr. f. Nervenhe.*, 1901-1902, xxi, 438.
- ⁵ Gordon: A Special Diagnostic Phenomenon in Cerebellar Disease. *Jour. Am. Med. Assn.*, 1908, 1, 461.
- ⁶ Grey: Staggering Gait, Limb Ataxia, the Romberg Test and Adiodokokinesia. *Jour. Nerv. and Ment. Dis.*, 1915, xlii, 670.
- ⁷ Grey: The Pointing Reaction and the Caloric Test. *Am. Jour. Med. Sc.*, 1916.
- ⁸ Grey: Posterior New-growths without Nystagmus. *Jour. Am. Med. Assn.*, 1915, lxxv, 1341.
- ⁹ Horsley: On Dr. Jackson's Views of the Functions of the Cerebellum, etc. *Brain*, 1906, xxix, 446.
- ¹⁰ Jackson: Case of Tumor of the Middle Lobe of the Cerebellum—Cerebellar Paralysis with Rigidity, etc. *Brain*, 1906, xxix, 425, 441.
- ¹¹ Larnelle: Sarcome du lobe droit du Cervelet et du Pédoncule Cérébelleux inférieur droit, etc. *Rev. Neurol.*, 1906, xiv, 204.
- ¹² Lossen: Beiträge zur Diagnose und Therapie der Kleinhirnabscesse. *Beitr. z. klin. Chir.*, 1903, xxxix, 804.
- ¹³ Mills and Weisenburg: Cerebellar Symptoms and Cerebellar Localization. *Jour. Am. Med. Assn.*, 1914, lxiii, 1813.
- ¹⁴ Muck: Ueber die ursache einer bei raumbeschränkenden Vorgängen in der hinteren Schädelgrube beobachteten eigentümlichen Schiefstellung des Kopfes. *München. Med. Wehnschr.*, 1914, lxi, 716; *München. Med. Wehnschr.*, 1915, lxii, 853.
- ¹⁵ Oppenheim: Lehrbuch der Nervenkrankheiten, 1913, ii, 1182.
- ¹⁶ Oppenheim: Lehrbuch der Nervenkrankheiten, 1913, ii, 1179.
- ¹⁷ Oppenheim: Lehrbuch der Nervenkrankheiten, 1913, ii, 1173.
- ¹⁸ Oppenheim: Lehrbuch der Nervenkrankheiten, 1913, ii, 1196.
- ¹⁹ Redlich: Lewandowsky's Handb. d. Neurol., iii, 604.
- ²⁰ Stewart and Holmes: Symptomatology of Cerebellar Tumors. *Brain*, 1904, xxvii, 522.

CALCULI IN THE SUBMAXILLARY GLAND AND WHARTON'S DUCT*

BY FRANK S. MATHEWS. M.D.

OF NEW YORK CITY

THERE are few surgical conditions in which such immediate and considerable relief of annoying symptoms can be obtained by such a comparatively minor operation as is the case with stone in the submaxillary salivary gland and duct. The writer has operated in six such cases under novocaine anæsthesia, removing the calculus through the mouth. The condition is not a very common one. I seem to have been rather unusually fortunate in seeing these cases, for in conversation with acquaintances of equal surgical experience, none have recalled seeing more than one or two. In the following cases the diagnosis has usually been overlooked by one or more physicians. This is explained in part by the infrequency of the condition and in part by the failure of the examiners to digitally explore the floor of the mouth.

CASE I.—The history of the first case was unusually interesting. A man came to me after a year's treatment by various physicians, complaining of pain and swelling under the jaw. At first, examination failed to reveal anything amiss. He then took from his pocket a piece of cheese which he had brought for the purpose and began to eat it, stating that cheese would usually bring on the pain and swelling. On this occasion he was not successful and was about to leave the office with the advice to call again when the swelling was present, when he turned at the door and said, "I believe it is coming." Within a few minutes there appeared a distinct swelling beneath the jaw and a ridge in the floor of the mouth following the course of Wharton's duct. A white speck was visible at the caruncula sublingualis. The duct was grasped with the thumb forceps just behind the caruncula and with scissors a nick was made in the duct and a calculus liberated in size not larger than a pin's head. The patient has had no trouble since.

The other cases may be briefly described as follows:

CASE II.—A very gouty, adult woman was treated for abscess of the jaw. This was poulticed for a time, but finally the abscess broke in the mouth. The abscess having broken, she was told that the trouble would subside. I saw her first several weeks later with a purulent discharge in the mouth and an induration in the

* Read before the New York Surgical Society, November 24, 1915.



FIG. 1.—Stones from Wharton's duct. The large central stone is from a case of Dr. Richard Derby.

CALCULI IN THE SUBMAXILLARY GLAND

floor of the affected side of the mouth. Palpation easily revealed the stone about as far back as the first molar tooth. The stone was removed by novocainizing the vicinity and incising through the mucosa of the floor of the mouth. The stone was larger than a pea.

CASE III.—A young woman presented herself with an elongated stone resembling in size and shape a grain of wheat. It produced intermittent obstruction to the duct and could readily be dislocated back and forth. The duct was opened near its orifice and the stone readily removed through the opening.

CASE IV.—A Porto Rican, almost immediately on arriving in New York, was taken with a chill and high temperature accompanied by pain and swelling in the submaxillary gland region. Under local anæsthesia the duct was incised and a slightly elongated, pinhead-sized stone was removed. The symptoms, however, did not subside. Pain and swelling continued and, several days later, another stone like the first was discovered and removed. Recovery followed.

CASE V.—A man past middle life had had inflammation in the floor of the mouth and, at intervals, a sinus discharging pus into the mouth. He was rendered uncomfortable but not unable to attend to his work. The tissues at the floor of the mouth felt brawny and a stone could be indistinctly palpated through the inflamed tissue. The stone was located not far from the *caruncula sublingualis*. On incision, a stone nearly the size of a pea was removed. There was a discharge of several drachms of pus from the dilated duct. A probe was inserted for more than an inch and came upon another stone firmly impacted in this situation. The duct was incised more liberally and stretched by opening a clamp within it. It was not possible, however, to dislodge the stone until the passage had been dilated by means of the little finger. The stone was then grasped with forceps and removed. When seen a month later, all induration had disappeared.

CASE VI.—This patient gave a history of intermittent inflammation and abscess in the submaxillary region, extending over seven years. He entered the ward of St. Luke's Hospital with temperature and a submaxillary phlegmon. An incision was made below the jaw into the indurated tissue but very little pus was evacuated. Several days later, when he was first examined by me, the swelling had not entirely disappeared. I suspected a calculus and under cocaine anæsthesia split and probed the duct, but was unable to find a stone. The patient was soon discharged from the hospital and a week later returned to the hospital with a stone which had been spontaneously ejected from the wound in the floor of the mouth.

REMARKS.—Except that one patient was gouty, there has been nothing in the history to point to an etiological factor in the above cases. Three of the patients were about thirty years of age, the others between fifty and sixty. Four were men and two women.

Symptomatically, the cases may be divided as follows:

(A) Patients in whom, at intervals, especially at meals, there is pain and swelling under the jaw but no sign of inflammation. In these cases, the stone is small and acts as a ball valve.

(B) With or without a history of intermittent swelling in this region, there suddenly appears a painful swelling with high fever, not unlike mumps. This may soon subside or go to the third condition.

(C) A hard swelling forms under the jaw and a ligneous œdema fixes the tissues of the floor of the mouth on the affected side. If pus forms, it is more likely to evacuate itself into the mouth than externally. Temperature subsides when the pus is evacuated but a variable amount of induration may persist indefinitely. A sinus discharging pus may remain for months.

Diagnosis.—This is made partly from the history. Swelling of the gland at meal times or a persistent swelling under the jaw and in the floor of the mouth should make one suspect the diagnosis of submaxillary calculus. The larger stones—that is, the size of a pea—can be palpated bimanually even in the presence of considerable œdema. The pinhead-sized stones can be felt, or perhaps seen, when they slip forward into the anterior part of Wharton's duct.

Treatment.—The stones in these six cases have all been removed through the floor of the mouth. In some cases, a sinus has been dilated with instruments or a finger; in other cases the duct has been incised over the stone. In the cases where a sinus exists and there has been prolonged suppuration, one would fear that cicatrization might produce a stricture of the duct and keep up the infection in the gland. I recall telling one patient that removal of the gland might prove necessary, but it never has been. Relief has been prompt and permanent. One should be on the lookout for multiple stones, a condition present in two of the above cases. Unless the calculus is found and removed, incisions in the mouth or externally will be followed by but partial and temporary relief. In Case V recurrent attacks extended over seven years.

TUBERCULOSIS OF THE TONGUE*

BY LUIGI DURANTE, M.D.

OF ROCHESTER, MINN.

FELLOW OF THE MAYO FOUNDATION

As deduced from autopsy reports and clinical records, tuberculosis of the tongue is infrequent. Willigk,¹ in 1317 necropsies of tuberculous subjects, found tuberculous lesions in the tongue twice only; Fowler,² in 382 autopsies, found it four times; Fischer,³ three times in 1500; Chiari,⁴ twelve times in 625; and Adami,⁵ in 417 autopsies of tuberculous cases, found none.

In statistics on pulmonary tuberculous lesions in German Sanatoria, Hamel⁶ records one single case of tuberculosis of the tongue in 12,369 subjects. Von Ruck⁷ gives the frequency of 0.38 per cent. in tuberculous subjects deduced from a material of 5000 patients studied in Winyah Sanatorium.

Literature covering the contributions to the casuistics collected by Dalla Vedova⁸ previous to 1906 and by me from January 1, 1901, to October 20, 1915, comprises about 250 cases of primary and secondary tuberculosis of the tongue, some of which are recorded without anatomoclinical details. Blancard's⁹ article reporting three interesting cases is the latest contribution.

The reason of the relative infrequency of tuberculous lesions of the tongue, an organ so near the source of infection, is probably due to two factors: (1) To the particular structure of the lingual mucosa which resists the direct penetration of the *Bacillus tuberculosis*; and (2) to the natural resistance which all striated muscles present to the lodgement of the bacilli. This resistance has been attributed by certain writers to antibacterial and antitoxic action, accentuated or reinforced by glycogen. It acts against microorganisms in general and against the *Bacillus tuberculosis* in particular, as was demonstrated *in vitro* by Teissier.¹⁰ It has also been ascribed to the continuous fibrillation which obstructs the attack of the bacilli. Nevertheless, though the facts are indisputable its fundamental reason remains obscure.

The larger proportion of these cases occur between the twentieth and fiftieth year; rarely above the latter age, though the case reported by Zintsmaster¹¹ was in the eightieth year. One case, that of Reimann,¹²

* Submitted for publication October 28, 1915.

occurred at nineteen years. None are recorded as having occurred in infancy, the age in which tuberculous lesions are so frequent and widespread.

These considerations seem to justify the deduction that the tuberculous process in the tongue is assisted by the causes common to middle age, such as trauma of the mucosa by the stem of a pipe, by carious teeth, by toxic glossitis, etc., and these causes, more frequent among men, explain the greater frequency of tuberculosis of the tongue among men. Chvostek's¹³ statistics show one woman to every four men; Schliferowitsch's¹⁴ show one in five cases; Delavan's¹⁵ show one in twenty-three.

The routes by which tuberculosis localizes itself in the tongue, though theoretic, are reducible to certain organs: (1) by the blood-vessels; (2) by the lymphatics; (3) by direct infection; and (4) by extension. Practically these routes cannot always be determined and the frequency of infection by a given route can be determined with scientific precision only with difficulty. Also, in cases in which the lesion of the tongue represents the late secondary localization of a primary bronchopulmonary tuberculous process it is always dubious to affirm or exclude by which of these routes, whether by the blood-vessels, the lymphatics or by direct inoculation by way of the excretion, the bacilli have reached the lingual focus. All three routes are possible, but no one character of the clinical course or of the microscopic findings permits a sure differentiation. The fourth route which I have stated as theoretically possible, that of the extension to the tongue by continuity of a tuberculous process in a neighboring region, I have not found recorded in the literature.

The tongue is one of the first organs which can come into contact with the infectious elements by way of the air or by the passage of food, and, by reason of the diminished vitality of the integument in circumscribed areas, determined by the many traumatic causes mentioned, can become primarily the seat of a tuberculous lesion. The theoretical possibility of a primary tuberculosis of the tongue is practically confirmed by two cases described by Clarke¹⁶ and by Schliferowitsch.¹⁴ These were operated on for tuberculous ulcers of the tongue and died from other causes. Tuberculous lesions were not found in other organs. Literature records¹⁷ many other cases of "primary" tuberculosis of the tongue, but this term should be accepted in a clinical sense only, since the cases were not controlled by autopsy.

In the majority of cases tuberculosis of the tongue has a localiza-

TUBERCULOSIS OF THE TONGUE

tion secondary to a tuberculous process in other parts of the organism, *e.g.*, in the anus (Burquoy¹⁸) and in the epididymis (Weber¹⁹).

The anatomical forms which tuberculosis of the tongue may assume do not represent a distinct anatomical entity, but often diverse forms of the same evolutionary process or varying anatomical aspects from case to case, and from region to region, according to the virulence of the bacilli and the reaction and local resistance of the tissues. For this reason they have a clinical rather than an anatomical interest. Whatever may be the final anatomico-clinical form of tuberculosis of the tongue, the beginning is always characterized by specific connective tissue, new formation of tuberculous nodules, which may be localized separately in the dermis of the mucosa or in the lingual parenchyma.

From this distinct initial localization of the tuberculous process may originate two clinically different types. The first, namely, the connective tuberculous new formation, if in the lingual dermis, assumes characteristics approximating cutaneous lupus. It presents itself initially as a plaque of grey color somewhat elevated above the surrounding mucosa without inflammatory reactions, and hard to the touch. It is formed by the grouping of small miliary nodules which, if they preserve the sclerotic form, are spoken of as glossodermatitis tuberculo-fibrosa. Should these ulcerate, they are called glossodermatitis tuberculo-ulcerosa. These two distinct forms of lingual lupus through the possible transition to another, sometimes assume aspects with difficulty referable to a fixed type. The lupous lesions of the tongue are always accompanied by lupous lesions of the buccal mucosa, of the nose, or of the skin of the face, and represent a complication not relatively rare. Licht Institute reported over 2000 patients affected by lupus vulgaris of the face in whom lingual lupus was noted only fifteen times.

When, on the other hand, the tuberculous elements affect primarily the parenchyma of the tongue (or rather the intramuscular connective tissues of the tongue, since the question arises whether a true primary tuberculous myositis ever exists), they may coalesce in such a way as to constitute a single nodule—nodular tuberculosis, confluent tuberculosis, granuloma tuberculare—or, if they may be disseminated in various regions—disseminated miliary tuberculosis, tuberculosis nodulare multiple or gummatous.

Each form, though the confluent more readily than the disseminated, may maintain its anatomic individuality for months and years and simulate a neoplastic lesion or the localization of tertiary lues. It tends in the early stage to caseous necrosis, becoming fluctuating (cold abscess of the tongue) and opening to the surface with the formation of

a large ulcer or a fistulous opening. The typical tuberculous ulcer has irregular margins, sinuous, soft and reddened, with a soft yellow base. It is surrounded by granulations easily bleeding. It may appear in any region of the tongue but with more frequency on the margins and tip. The adenitis which accompanies it is often bilateral and slightly painful to pressure.

From a review of the clinical history one deduces that the persistence of the two clinical individualities, the nodular form and the ulcerative form, is influenced by the condition and the course which the tuberculous infection assumes in other parts of the body, of which the lingual lesion is generally a secondary localization. The form which for most of the time maintains the nodular type, single or multiple, accompanies a tuberculous infection, generally of the lung, with a slow course, not destructive, or is an indirect primary form. The forms which tend rapidly to caseous necrosis are habitually concomitant with and secondary to deep and destructive lesions of other organs.

Literature records still another form of tuberculosis of the tongue of a verrucose (Francois-Dainville ²⁰) or papillomatous type (Danlos and Levy-Frankel ²¹), so-called from the aspect which the mucosa may assume when its papillæ become infiltrated by a tuberculous granuloma of the lymphoid type. There has never been described in the tongue the type of inflammatory hypertrophic tuberculosis of a pseudoneoplastic character found in the smooth musculature of the pylorus, of the cæcum and in striated muscles.

The result of the search for the bacillus of Koch in tuberculous glossitis is usually positive; though sometimes in cases of undoubted tuberculosis of the tongue it may be negative (Dalla Vedova,⁸ Campbell,²² Trimble,¹⁷ Schliferowitsch ¹⁴). In order to exclude the presence of the specific bacteria in the affected tissues it is necessary to supplement the biologic test by the use of both Ziehl-Neelson's and Gram's methods of staining. We know, in fact, following the works of Mircoli,²³ Much,²⁴ Constantini,²⁵ etc., that contemporaneously with the morphologic variability of the tuberculosis bacillus its chemical properties and staining reactions vary also. There exists, indeed, a species of tuberculosis bacillus of the typical form of rod which does not stain by Ziehl's method but does stain by the prolonged method of Gram; and a granular form which has a chromatin affinity exclusively for the Gram stain.

The symptoms of lingual tuberculosis vary following the anatomical form which it assumes and following its stage of evolution. The char-

TUBERCULOSIS OF THE TONGUE

acteristics of tuberculous infection in all the organs, the absence of subjective disturbance in the initial stage of the lesion, marks the beginning of tuberculosis of the tongue which develops slowly and almost painlessly until it assumes the ulcerative form. At this stage there is an abundant salivation (ptyalism) from the specific reflex secretory stimuli pertaining to the ulcerated surface and mild spontaneous tenderness through the diffusion of the inflammatory process to the lymphatic sheaths of the nerve filaments and through the pain due to the passage of food. Such pain, together with the inflammatory condition, often limits the normal mobility of the tongue on account of the facility with which it is complicated by secondary infection, accompanied early by a somewhat painful regional adenopathy. This adenopathy in general is absent in the closed, non-ulcerative form of lingual tuberculosis.

Diagnosis.—The diagnosis in the initial stage of the process of evolution presents generally great difficulty when the attempt at diagnosis is limited to the direct physical findings. A review of the literature in this connection impresses one with the frequency with which tuberculosis of the tongue is confused with epitheliomatous neoplasm or with tertiary lues. The first, most common, diagnostic error in this connection has often led to the amputation of the tongue and to the accompanying complementary operations of the neck, as in cases reported by Albert,²⁶ Hansemann,²⁷ Bull,²⁸ Dalla Vedova,⁸ Euteneuer.²⁹ The second diagnostic error leads to mercurial treatment which has been actually employed in 180 reported cases.

Lupus of the tongue, in whatever aspect it presents itself, is not difficult to diagnose. It may be confused with the papillary or ulcerative lesions of lues; but the generic criteria which serve to differentiate the two lesions in any organ, anamnesia, the trial of specific serous methods of diagnosis, therapy, etc., or, better, the microscopic examination of the excised tissue, will serve to make the differentiation.

All the other forms of lingual tuberculosis present serious difficulties unless recourse be had to microscopic examination. The nodular form of intralingual tuberculosis, confluent or disseminated, in the beginning is quiet, without pain, not accompanied by a swelling of regional glands and is simulated more frequently by the gummatous lesions of lues. To exclude the syphilitic affections, it should be noted that these have a predilection for the base of the tongue, while tuberculosis elects the tip; they are less painful than tuberculous granulomata and in a few weeks ulcerate. Again, one should use the criteria mentioned above in the differentiation of the lupous form from syphilis of the tongue.

This nodular form of lingual tuberculosis may also be confused with actinomycosis, rarely with fibroma, lipoma or sarcoma. Criteria of approximate differentiation can be found if we remember the characteristics noted as pertaining to each pathologic form. Sure criteria are difficult to find if we do not employ the direct examination of the tissue of the tumor.

The ulcerative form of lingual tuberculosis, especially if the lesion is primary and alone, assumes great surgical interest from its being easily confused with cancerous ulcer, because this is of much greater frequency than the first and because both have a predilection for the same age, the same sex, and the same lingual region. In typical forms the two ulcers can often be differentiated by a single direct examination; but often the tuberculous ulcer does not present the characteristics which I have recorded, but occurs with margins and with the base moderately indurated by inflammatory infiltration (Zintsmaster,¹¹ Dally,³⁰ etc.), spontaneously painful from the diffusion of the inflammatory process in the lymphatics and the nerve filaments. In such a case it is obvious how an error may easily take place because the differential characteristics, described for the two ulcers and for those omitted because they are intuitive, have substantially an academic value, not a practical one.

It is therefore not prudent that the diagnosis of ulcerous lesions of the tongue should be determined by a single method or by the clinical signs, but should be founded on an accurate histobiologic test. The removal of tissue for the histobiologic test and for the inoculation of guinea-pigs is the diagnostic means most certain and is the method of election to differentiate the neoplastic lesion of the tongue from tuberculosis. At least the histologic examination of the base of the ulcer in frozen sections during the operation should be done, thus sometimes preventing greatly destructive and useless intervention.

Prognosis.—The prognosis is favorable when the tuberculosis of the tongue presents itself as a primary and unique lesion; less so when it is primary but has a multiple localization. It is generally unfavorable when the lingual lesion presents itself as a late localization and secondary as a bronchopulmonary process. In such cases it assumes the gravity which the tuberculous process has in the principal focus and does not follow the evolution.

Treatment.—The therapy of election, avoided by previous authors, has been operative when the tuberculous lesion of the tongue was single and circumscribed. In the multiple and diffuse lesions the treatment



FIG. 1.—Case IV. Tuberculosis of the tongue—multiple tubercles forming a single nodule. Section stained with Weigert-v. Gieson stain. Photomicrograph (80 diam.) showing four typical miliary tubercles, forming one nodule, situated in the muscular stratum, surrounded by dense connective tissue.



FIG. 2.—Case IV. Tuberculosis of the tongue—multiple tubercles forming a single nodule. Section stained with Weigert-v. Gieson stain. Photomicrograph (90 diam.) showing a typical tubercle and a nodule, containing lymphoid cells only, side by side; the lymphoid cells may also be seen invading the connective tissue between the muscle-bundles.



FIG. 3.—Case V. Tuberculosis of the tongue—ulcerating stage. Section stained with Weigert-v. Gieson stain. Photomicrograph (100 diam.) showing the margin of the ulcer and containing small-cell infiltration and typical nodular lesions.



FIG 4—Case V. Stained with Unna-Pappenheim stain. Photomicrograph (220 diam.) showing the invasion of the papillary tunic proprii by small-cell infiltration and giant cells.

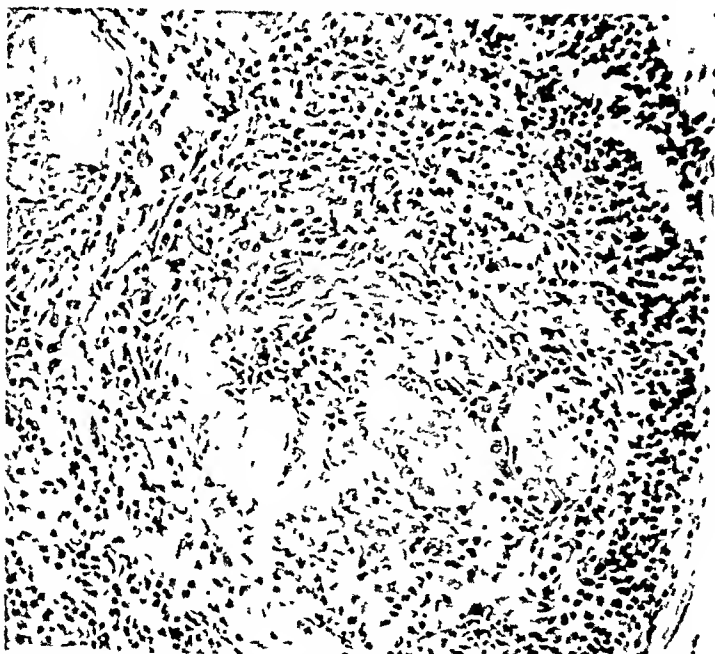


FIG 5—Case IV. Histogenesis of the giant cells. Section stained with Weigert-v. Gieson stain. Photomicrograph (220 diam.) showing various stages in the formation of giant cells by the fusion of epithelioid cells in a large typical tubercle.

TUBERCULOSIS OF THE TONGUE

has been local with the common cautery. I have studied the following cases from the material in the Mayo Clinic:

HISTOLOGIC FINDINGS. SPECIMENS FIXED IN 10 PER CENT. FORMALIN, BLOCKED IN PARAFFIN, SECTIONS STAINED WITH WEIGERT-VAN GIESON AND UNNA PAPPENHEIM

CASE I.—The margin of the ulcer (involving the mucosa, the tunica propria and in parts even the muscular stratum) shows extensive small-cell infiltration of the connective tissue, but no typical tuberculous nodules are present. In the lower strata (of the margin of the ulcer) a few muscle fibres may be seen; these fibres have been split up into fragments by the small-cell infiltration, and are both degenerated and atrophic. The fundus of the ulcer, on the contrary, contains a great number of miliary foci, in which giant-cells may be seen; the latter are generally surrounded by lymphoid tissue, though a few epithelioid cells are found here and there. Caseous degeneration of these miliary tubercles appears to be extremely rare. The solitary tubercle as well as the larger tuberculous lesion, produced by the conglomeration of small nodules, is walled off by a dense zone of connective tissue. Extensive perivascular infiltration is found in every section.

Histologic Diagnosis.—Confluent ulcerating tuberculous granuloma.

CASE II.—The margins of the ulcer are composed of an intense small-cell infiltration, which has taken the place of all the original parenchyma. Here and there the infiltration is somewhat less dense, the cells are seen clustered together in groups and on the periphery of these groups lymphoid cells are found breaking up the muscular layer, the latter being atrophic and staining badly. In the lower strata, forming the fundus of the ulcer, numerous typical nodules appear; some of these, however, contain only lymphoid and epithelial cells. A few giant-cells are found scattered amongst the invading lymphoid tissue, although no attempt at tubercle formation could be traced. The blood-vessels show extensive perivascular infiltration.

Histologic Diagnosis.—Confluent ulcerating tuberculous granuloma.

CASE III.—The specimens removed at operation have not been preserved.

CASE IV.—Of the tuberculous nodule several blocks excised at different angles were examined in this case; all contain the same histologic picture. Numerous miliary tubercles are found, consisting of solitary nodules and of confluent groups of nodules separated by dense connective tissue containing very few nuclei (Fig. 1). The formation of individual nodules and the number of epithelial cells found in these nodules is characteristic of this particular type of tuberculosis of the tongue. In many of the nodules containing giant-cells of varied shapes and sizes, the nuclei being arranged peripherally or scattered throughout the cytoplasm, it is clearly shown that the giant-cell was formed by a gradual fusion of epithelial elements. The giant-cells appear to represent a form of syncytium due to the fusion of epithelial cells. In this case nodules containing lymphoid cells only are extremely rare. Bundles of muscle fibres that have remained intact are few and far between. They present the picture of disintegration already described above. They appear to have been separated and pushed aside by the infiltrative process when the latter began to invade the connective tissue. As usual the blood-vessels show extensive perivascular infiltration.

Histological Diagnosis.—Intraparenchymal tuberculous granuloma, containing miliary nodules.

CASE V.—The margin of the ulcer, which involves the epithelium, the tunica propria and, in part, the muscular layer, shows intense small-cell infiltration as well as typical, nodular tuberculous lesions. Fig. 3 represents a large sclerotic tubercle found on the edge of the ulcer at the periphery, of which numerous giant-cells of various shapes and sizes may be seen. The inflammatory infiltration extends as far as the intrapapillary connective tissue in some places, invading the epithelium and paving the way for ulceration. The fundus of the ulcer also shows extensive small-cell infiltration and contains a great number of typical nodules in whose outer zone giant-cells are seen. A few muscle-fibres are found, both in the fundus and in the margin of the ulcer. These fibres are atrophic and stain badly. Extensive perivascular infiltration is seen around all the blood-vessels.

Histologic Diagnosis.—Intraparenchymal tuberculoma, containing confluent and ulcerating tubercles.

SUMMARY OF HISTOLOGIC FINDINGS

As may be readily seen from the description of the 4 cases mentioned above, the histologic picture found in tuberculosis of the tongue does not differ materially from that which is seen in the tuberculous lesions of other organs, especially of the striated muscles. Apart from the small-cell infiltration, which is not a typical feature in itself, the typical nodules characterizing tuberculous lesions may be observed in every case. In 2 out of 3 of our cases (presenting the ulcerating type of tuberculosis) these characteristic nodules could be observed only in the lower strata of the margin and in the fundus of the ulcer, a fact which suggests that in microscopic diagnoses both margin and fundus should be examined with special care. Three cases gave no data whatever concerning the actual histogenesis of the giant-cells. In the fourth, however, the formation of giant-cells as a direct result of syncytial fusion of epithelioid cells could be repeatedly demonstrated. The fact that extensive perivascular infiltration was found in every case seems to indicate that hæmatogenous infection plays a prominent part in the propagation of tuberculosis in the tongue.

SUMMARY OF CLINICAL OBSERVATIONS

Of the 5 cases of lingual tuberculosis I have described, 2 were women; in every case the age of the patient was between twenty and sixty. None of these came to autopsy. The question, whether any of these can be rightly described as "primary" tuberculosis of the tongue, must consequently be decided by the clinical findings. In Cases I and

TUBERCULOSIS OF THE TONGUE

IV no evidence of other tuberculous foci could be obtained by clinical means. In the 3 remaining cases, the lesions of the tongue appeared to be tardy secondary manifestations of primary pulmonary tuberculosis.

In 4 cases (I, II, III, V) the lesions of the tongue had already assumed the ulcerating form at clinical examination; the ulceration was most marked at the edges, the granuloma itself being embedded deep down in the tissue.

In Cases II, III and V the ulcer showed the typical characteristics of the disease, but in Case I both margins and fundus appeared hard and infiltrated and suggested an ulcerating epithelioma.

Case IV was of the nodular type and showed no change for ten years, at the end of which time the patient came for operation. The importance of the conditions under which tuberculous lesions develop, and the influence of these conditions on the progress of the disease and on the histologic picture which results, may be clearly seen in Case IV: The patient's personal history as well as the family history were entirely free from tuberculosis, the lesion found in his tongue may be called primary inasmuch as no other foci could be discovered during clinical examination; the lesion itself assumed the form of a "closed" (circumscribed) nodule, in which no changes occurred during a period of ten years.

In the other cases (I, II, III, V), however, all of which had a personal as well as a family history of tuberculosis, the tuberculous lesion in the tongue very soon (3 or 4 months) reached the ulcerating stage.

It is therefore safe to assume that the individual reaction of the body plays a far greater part in defining the histologic picture of tuberculous lesions, than the tissue in which the lesion is found.

In the four cases of "open," ulcerating tuberculosis of the tongue the regional lymph-glands were found to be involved. In Case IV, in which the intralingual granuloma remained intact, no such involvement was found.

Clinical diagnosis was easy in Cases II, III, and V, in which broncho-pulmonary lesions were present together with the ulcer of the tongue; a tuberculous lesion was suspected in Cases I and II. No definite diagnosis could be made (clinically) of Case IV, as no evidence of tuberculosis in other organs could be obtained.

In every case, however, a histologic diagnosis could be made during operation by means of frozen sections, and the histologic findings decided the course to be taken so far as operative and therapeutic treatment were concerned.

| Case | Date of admission | Office number | Sex | Age | Family history of T. B. | Accompanying tuberculous lesions | Trauma | Character of lesions | Number of lesions | Time of appearance before operation | Localization | Glandular involvement (cervical) | Treatment |
|------|-------------------|---------------|-----|-----|-------------------------|----------------------------------|---------------|----------------------|-------------------|-------------------------------------|------------------------------------|----------------------------------|--|
| 1 | Sept. 28, 1904 | 289 | M | 40 | .. | ..... | Smoker (pipe) | Ulcer 8x6x4 mm. | 1 | 3 mo. as deep-seated nodule | Left edge 2 cm. from point | + Bilateral | Excision. |
| 2 | Jan. 2, 1906 | 1155 | F | 30 | .. | Bronchopulmonary T.B. | ..... | Ulcer 12x8x6 mm. | 1 | 3 mo. as deep-seated nodule | Right edge 1 cm. from apex | + Bilateral | Microscopical examination for diagnosis. Cautey. |
| 3 | June 8, 1907 | A558 | M | 46 | * | Pulmonary T.B. | ..... | Ulcer 15x10x5 mm. | 1 | 2 mo. as superficial nodule | Right edge 2 cm. from apex | + Bilateral | Microscopical examination for diagnosis. Cautey. |
| 4 | Jan. 28, 1909 | A19632 | F | 46 | .. | ..... | ..... | Nodule under mucosa | 1 | 10 years as nodule | Entire right half 2 cm. from point | ..... | Excision. |
| 5 | Feb. 2, 1915 | 123733 | M | 24 | * | Pulmonary T.B. | Smoker (pipe) | Ulcer 12x6x5 mm. | 1 | 10 mo. as deep-seated nodule | Right edge 3 cm. from apex | + Right side | Microscopical examination for diagnosis. Cautey. |

TUBERCULOSIS OF THE TONGUE

REFERENCES

- ¹ Willigk: Quoted by von Ruck, *l.c.*
- ² Fowler, J. K., and Godlee, R. J.: *The Diseases of the Lungs*. Lond. & New York, Longmans, Green & Co., 1898, xv, 715, pp. 80.
- ³ Fischer: Quoted by Nelson, S. *Über zwei Fälle von Zungentuberkulose*. Inaug.-Diss., Freiburg, 1902.
- ⁴ Chiari, V.: *Berliner klin. Wchnschr.*, 1899, xxxvi, 984.
- ⁵ Adami, J. G., and McCrae, John: *Analysis of One Thousand Consecutive Autopsies*. *Proc. Sixth Internat. Cong. on Tuberculosis*, 1908, i, pt. 1, 325-333.
- ⁶ Hamel: *Deutsche Heilstätten für Lungenkranke: geschichtliche und statische Mitteilungen*. *Tuberk.-Arb. a. d. k. Gsmdhtsamte*, 1905, Hft. 4, 1-203.
- ⁷ Von Ruck, S.: *Tuberculosis of the Tongue*. *Laryngoscope*, 1912, xxii, 1190-1200.
- ⁸ Dalla Vedova, R.: *Per la diagnosi della tubercolosi della lingua*. *Arch. ed atti d. Soc. ital. di chir.*, 1907, xx, 101-137, *Policlin.*, Sez. chir., 1907, xiv, 89-113.
- ⁹ Blancard, W.: *Tuberculosis of the Tongue*. *Jour. Cutaneous Dis.*, 1915, xxxiii, 696-702.
- ¹⁰ Teissier, Pierre: *Difficultés de constatation et de recherche du bacille tuberculeux*. *Proc. Sixth Internat. Cong. on Tuberculosis*, 1908, i, pt. 1, Sec. 1, 295-297.
- ¹¹ Zintsmaster, L. B.: *A Case of Tuberculosis, Resembling Carcinoma, in the Tongue of an Old Man*. *ANN. SURG.*, 1903, xxxvii, 52-55.
- ¹² Reimann, A.: *Über tuberkulöse Geschwüre der Zunge*. Inaug.-Diss., Breslau, 1880.
- ¹³ Chivostek, F.: *Über das tuberkulöse Zungengeschwür*. *Allg. Wien. med. Ztg.*, 1884, xxix, 209, 224, 234, 260, 284.
- ¹⁴ Schliferowitsch: *Über die Tuberkulose der Mundhöhle*. Inaug.-Diss., Odessa, 1887.
- ¹⁵ Delavan, D. B.: *Seven Cases of Buccal Tuberculosis; with Remarks upon Tubercular Ulceration of the Tongue*. *New York Med. Jour.*, 1887, xlv.
- ¹⁶ Clarke, W. F.: *Tubercular Lupus of Tongue, Palate, and Gums*. *Trans. Path. Soc., Lond.*, 1876, xxvii, 148-149.
- ¹⁷ Chappel, W. F.: *The Early Appearance, Diagnosis and Treatment of Tuberculosis of the Upper Air Tract*. *Jour. Am. Med. Assn.*, 1903, xl, 495-500.
 Farr, C. E.: *Tuberculosis of the Tongue*. *Med. Rec.*, 1914, lxxxviii, 727.
 Frank: *Primäre Tuberkulose Geschwüre der Zungen*. Quoted in Ziegler: *Lehrbuch*, Jena, Fischer, 1908, 558.
 Gershun, T. M.: *Primary Tuberculosis of the Tongue*. *Vrach. Gaz.*, 1912, xx, 55, 97.
 Lagomarsino, A.: *Sobre un caso de tuberculosis primitiva nodular diseminado de la lengua*. *Semana méd.*, 1912, xix, 1216.
 Marotta, R. A.: *Tuberculosis primitiva de la lengua*. *An. d. Circ. med. Argent.*, 1906, xxix, 223-227.
 Nannini, G.: *Un caso di tuberolas primitiva della lingua*. *Gazz. d. osp.*, 1914, xxxv, 331-333.
 Provera, C.: *Un caso di ulcera tubercolare primitiva della lingua*. *Morgagni*, 1906, xlviii, 27-31.
 Trimble, W. B.: *Lingual Tuberculosis. Primary?* *New York Med. Jour.*, 1914, xcix, 467-470.

- ¹⁸ Burquoy: Des ulcérations tuberculeuses de la langue et de l'orifice anal. Thèse de Paris, 1874.
- ¹⁹ Weber: Quoted Dalla Vedova, *l.c.*
- ²⁰ Francois-Dainville: Tuberculose verruqueuse de la langue. Bull. et mém. Soc. anat. de Par., 1904, lxxix, 224-226.
- ²¹ Danlos and Levy-Frankel: Tuberculose papillomateuse de la langue. Bull. Soc. franc. de dermat. et syph., 1909, xx, 134-136.
- ²² Campbell, J. T.: A Case of Tuberculous Ulceration of the Tongue. Laryngoscope, 1907, xvii, 233-234.
- ²³ Mireoli, S.: Recenti conquiste italiane nel campo della. Gazz. d. osped., 1900, xxi, 504-511.
- ²⁴ Much, H.: Über die Granuläre, nach Ziehl nicht färbbare Form des Tuberkulosevirus. Beitr. z. Klin. d. Tuberk., 1907, viii, 85-99.
- ²⁵ Costantini: Il valore del metodo di Much per la colorazione dei bacilli tubercolari. Riforma med., 1912, xxviii, 1121-1128.
- ²⁶ Albert, E.: Amputation der Zunge wegen eines grossen Tuberkelknotens, der für Carcinom gehalten wurde. Wien. med. Presse, 1877, xviii, 44-46.
- ²⁷ Hansemann, Albert, Bull, Capart: Cited by Dalla Vedova.
- ²⁸ Bull, W. T.: A Case of Primary Tuberculosis of the Tongue; Presentation of the Patient Three Years after Total Extirpation by Kocher's Method. Med. Rec., 1889, xxxv, 62.
- ²⁹ Euteneuer: Über Tuberkulose der Zunge. Inaug.-Diss., Bonn., 1872.
- ³⁰ Dally, J. F. H.: A Case of Tuberculosis of the Tongue. Brit. Med. Jour., 1903, ii, 1463.

TANNERS' ULCER*

CHROME SORES—CHROME HOLES—ACID BITES

By JOHN CHALMERS DaCOSTA, M.D.

AND

JOHN F. X. JONES, M.D.

OF PHILADELPHIA, PA.

WITH BACTERIOLOGICAL AND PATHOLOGICAL STUDY

By RANDLE C. ROSENBERGER, M.D.

A SURGEON should know much of the nature of many callings in order that he may understand the particular dangers to which the workers in each trade are exposed. In some callings the workman is in danger of wounds and injuries more or less grave; perhaps often fatal. The stress and strain of some shatter the nervous system. In some lack of exercise and contaminated air undermine the general health. In some irritant materials produce lesions of the surface of the body. In some poisons are absorbed and produce disease or death. In statistical tables, callings in which there is definite risk are designated as *dangerous occupations*.

We might give the following instances: Structural iron workers; workers in oil refineries; subway laborers; miners; railroad men; firemen in large cities, and workers in various other strenuous vocations are exposed to violence which may cause trifling injury or perhaps frightful mutilations. Caisson workers are liable to a peculiar disease. Locomotive engineers, overharassed professional men, business men during a financial crisis, persons living on the edge of ruin or exposure to disgrace, women in men's occupations, suffer from nervous strain and its resultant maladies.

In estimating the strain of an occupation it is interesting to note that the suicide rate in any calling is a fair measure of its strain and that the suicide rate is lower among beggars than in any other class.

Certain occupations cause definite neuroses. We may mention writer's cramp, telegrapher's cramp, pianist's cramp, typewriter's cramp, sewer's cramp, hammerswinger's cramp, etc. Sweatshop workers and dwellers in sunless alleys, those who live in the rabbit warrens of the tenements, are peculiarly liable to tuberculosis.

Among dangerous callings are the following: Work in lead, antimony, arsenic, mercury, copper, yellow phosphorus, carbolic acid,

* Read before the Philadelphia Academy of Surgery, October 4, 1915.

bisulphide of carbon, picric acid, certain petroleum products, nitro-explosives, and nickel carbonyl. The absorption of poisonous materials into the tissues of one who works with poisons produces results depending upon the material and the amount absorbed and the condition of the subject.

The local effects of irritants used in industrial processes are seen among workers in many callings. There are many forms of trade eczema and industrial ulcer. Electro-platers who work in strong soda solution may develop ulcers and fissures of the hand. Electro-platers may also get cyanogen sores. Bakers' itch is from working in flour and yeast; grocers' itch from sugar. Shoemakers, bartenders, stone-cutters, plasterers, bricklayers, printers, bookbinders, cigarmakers, photographers, chemists, surgeons, wood-workers and metal cleaners are prone to occupation eczema. Anthracene, a material from which alizarin dyes and a paint to preserve wood are made, is apt to cause the development of pustules on the skin and sometimes cause cancer. Workers in coal-tar and paraffin workers are liable to dry erythema, acne, pigmentations, pustules, boils, keratoses and warts; and a wart or an area of keratosis may become cancerous. In aniline and benzidine workers not only does cancer of the skin occur but also cancer of the bladder. Lampblack workers suffer from eczema of the toes, wool-sorters may get anthrax, salt grinders and salt handlers may develop ulcer of the nasal septum, and mother-of-pearl grinders may develop hypertrophy of a bone or bones and may suffer attack after attack of bone inflammation.

Among irritant materials used in certain industrial processes we must note chromic acid and its salts. This material in some form or other is used in photography, in calico printing, in bank-note printing, the ceramic industry, the manufacture of safety matches, dyeing, glass making, bleaching oils, purifying wood spirit and tanning hides.

It has long been known that the dust of chromic acid or the chromates can cause ulceration of the nasal septum and that the acid or the chromates, as dust or in solution, by acting upon the skin may cause ulcers.

Over twenty years ago one of us (DaCosta), then one of Professor Keen's assistants in the Jefferson Hospital, became interested in certain peculiar ulcers to which tanners were found to be liable, although occasionally a cloth handler or a dyer developed one. These ulcers were found to be most common on the hands, especially the fingers, but the feet were not entirely exempt. It was noticed that the ulcers tended to penetrate deeply, that few of them tended to spread much

laterally, that they were painful, resisted all treatment until the occupation was abandoned, showed no sign of tuberculosis (cultures for tubercle bacilli proving negative), were not improved by antisyphilitic treatment, and after healing left permanent scars.

Further investigation showed that none of those attacked had worked in the old tanbark methods of tanning, but all had worked in the then recently introduced chrome process, which was being actively developed for the tanning of kid by Mr. Robert Foederer, of Philadelphia.

The only workmen in the tanneries who suffered were those who actually worked with the bichromate salts. Surgeons had heard of lesions arising in workmen engaged in the manufacture of bichromate of potash in chemical works, the lesions consisting of cutaneous ulceration and perforation of the cartilaginous septum of the nose. There was no record of such lesions occurring in tanners. Previous to this time the chromic process had scarcely been used.

A study of these ulcers was undertaken and a number of cases were investigated clinically and bacteriologically. The assistant engaged in the bacteriological part of the work tired and fled, the study broke down and was not resumed until recently.

Throughout the years which followed that abortive investigation every now and then a tanner suffering from an ulcer has presented himself for treatment at the surgical dispensary. The assistant came to speak of such sores as "tanners' ulcers" or "leather workers' ulcers." We still see these cases, though far less often than formerly because in certain parts of the tanning process machines have been substituted for hands.

Recently through the kindness of the proprietors of a number of tanneries in Philadelphia, Wilmington and Camden, we have seen and gathered together for study a number of these cases and purpose report upon them.

We will first set forth the literature on "chrome sores" in general, that is to say, of chrome sores as they occur in various occupations. We will then report upon our cases which occurred among tanners and will discuss the condition.

"CHROME SORES IN GENERAL"

Chromium and the chromates were discovered by Vauquelin in 1797. The chromates have been employed in certain manufacturing establishments since before 1819. On page 156 we mention some of the industries in which they are used.

Robert Christison (*A Treatise on Poisons*, 1829) tells us that chrome sores were described to him by his late colleague, Duncan, of Glasgow. His patients were dyers who worked in vats containing bichromate of potash. Christison states that these sores spread deeply but not laterally.

D. G. Gmelin, of Tübingen, in his *Treatise on the Effects of Some Metals* (quoted in *Edinburgh Med. and Surg. J.*, vol. xxvi, 1826), speaks of sores developed by Glasgow dyers who immersed their hands in bichromate solutions. The sores do not extend laterally, but go deeper and deeper and may penetrate the hand or forearm.

T. J. Ducatel, of Baltimore, studied chrome sores in chemical workers (*Manual of Practical Toxicology*, 1833). He states that if one who works in chrome has an abrasion of the cuticle a painful ulcer results; but if the cuticle is unbroken, even a strong solution fails to produce ulcerations. The writer states that chrome sores are well known to Baltimore chemical workers in factories where bichromate of potash is made. He asserts that Duncan's cases among dyers were due to free chromic acid in the fluid. He describes these sores in the words of Gmelin without giving credit to the celebrated Tübingen professor. He presumes that the neutral chromate can only induce slight inflammation. The bichromate causes much more violent symptoms.

Ducatel, in a footnote, quotes Baer as having seen twenty cases of chrome ulceration. Baer describes the ulcers as painful, burrowing, persisting in spite of treatment and tending to penetrate the limb unless the victim abandons his work. Baer asserted he had seen ulcers on parts of the body which the solution did not touch, and that such ulcers could only have been caused by the vapor of chromic acid.

In 1851 Chevalier, Sr., addressed a note to the Institute calling attention to the dangers run by those who worked in chromates. Heathcote (*Lancet*, February 4, 1854) reported ulcers of the throat occurring in workmen who handled chromate of potash, and claimed that such lesions might be fatal.

M. A. Delpech (*Bulletin de l'Académie Impériale de Médecine*, vol. xxix, 1863-1864) considers certain ailments of those who make bichromate of potash. He mentions pustules and gangrenous sores of the hands and feet (especially of the sides of the fingers and toes). These ulcers he says exhibit temporary induration, tend to perforate, and leave indelible scars. He further points out that ulcerous eruptions may occur on the arms, limbs, trunk or genitals; that ulcers are due to direct contact with neutral or acid chrome; that bichromate is the more active irritant of the two; that in some subjects rhinitis arises and ends

in destruction of part of the cartilage of the nasal septum; that the perforation is usually rapid and the cartilage never reforms; that the sense of smell is seldom lost; that in some cases the perforation is insidious, without coryza; that the eyes, upper respiratory passages and stomach remain unaffected; that snuff takers seldom lose the septum from chrome perforation; that the nasal trouble is due to the vapor from the caldrons; and that both septum perforation and cutaneous ulceration are due to the escharotic action of chromic acid or a chrome salt.

In the same volume of the journal containing Delpech's paper is a paper by Hillairet on the dangers in making bichromate of potash.

In 1863, Chevalier, Sr., and Bécourt published a paper on the accidents to which chrome makers are liable (*Annales d'Hygiène*, July, 1863). The paper is founded upon an investigation conducted by Clouet and contains data obtained from Zuber and Ehrmann, of Riksheim, and Isaac Tyson, of Baltimore.

In January, 1869, and in January, 1876, Delpech and Hillairet (*Annales d'Hygiène Publique et de Médecine Légale*) published studies of the accidents which occur to chrome workers. The paper contains a review of the very scanty literature, the report of an investigation of the hygienic conditions of chrome workers, a description of the process of manufacture and a clinical study of the health impairment due to chromate. It describes chrome sores of the hands and cases of perforation of the nasal septum and mentions that nasal perforation results from inhalation of chromate dust. In the same journal in January, 1876, there is published the second part of their study. The authors mention that though bichromate is distinctly more irritating than neutral chromate, neutral chromate can cause irritation (this fact has been disputed by manufacturers). They cite instances of animals who have walked about in a slop of neutral chromate and have developed ulcers on the feet, and report cases of perforations of the nasal septum due to the neutral salt.

The authors say that the ulcers are characteristic, that they are due to escharotic action and most of them arise in excoriations. In some cases there is perforation of the cartilage of the nasal septum, in some bronchitis, headaches and loss of weight. Ulcers of the throat simulating syphilis have been reported, but it is unquestionable if chrome causes them. If the hands are free from abrasions, they can be put in vats freely, but the slightest break will lead to ulcer. If there is an excoria-

tion, violent pain will be experienced at the moment of contact with the chrome salt. These ulcers are much worse in the cold of winter.

After an ulcer once begins it quickly indurates and in a few days a spongy, soft slough forms. These sloughs separate very slowly by peripheral ulceration. The sloughing area does not increase laterally unless more chromate is introduced, but it goes in deeper and deeper and usually reaches the bone; but once it does so, it stops. The edges of these ulcers are sharp cut and frequently show cicatrization. The core or slough is slowly separated, leaving a clear ulcer with a gray floor.

If a man stops work at once after the beginning of the ulcer, the sore quickly heals, but even then it leaves a permanent scar. The most common situations are in the articular folds on the back of the hand. He may get vesicles, pustules or eczema on various parts of the body. Sores on the body may be due to scratching with contaminated hands or may be due to dust settling through openings in the garments (it is to be remembered that the paper deals with chemical workers). The authors do not think that the systemic absorption of the chromium ever causes poisoning. Those who take snuff seldom develop perforation of the septum. Smell is seldom lost after septal perforation. After perforation has once occurred a second one never develops, because the contact of the mucous membrane of the two sides of the nasal passage has become impossible. The authors do not think that abrasions are a necessary antecedent of ulcers. If they were ulcers could not form on so many different parts of the body.

The writers then discuss at length industrial hygiene and prophylaxis.

In the quarterly publication for *Judicial Medicine*, vol. x, 2, 1895 (edited by A. Wernich), Dr. Paul Muller discusses perforating ulcer of the nasal septum. He says that the dust of many salts besides the chromates may be responsible. He mentions sodium chloride and potassium chloride.

Dr. J. William White (*University Medical Magazine*, November, 1889) reported a case in which he had used chromic acid as a cauterant for vegetations of the labia majora and nymphæ. The patient died within twenty-four hours, probably from the toxic action of the chromic acid that had been absorbed. The postmortem showed that the kidney tissue and the liver tissue contained sodium chromate. This acute case proves that absorption of toxic doses from the surface is at least possible.

Edward Curtis and R. J. E. Scott in Wood's *Reference Hand Book*

of the *Medical Sciences*, 3rd edition, say that general poisoning from the continued absorption of small quantities of chromium is very questionable. They state that no *chronic* condition thus caused has been found in man.

Von Lewin (*Lehrbuch der Toxikologie*) says that chromium salts can be absorbed through wounds, from the skin and from mucous membrane. He cites the case of a boy who placed a piece of potassium bichromate, the size of a coffee bean, in his nose and went to sleep. In an hour he had developed serious symptoms of poisoning.

In Sajous's *Analytical Cyclopædia of Practical Medicine*, 1913, vol. iii, we read that potassium bichromate when applied locally to the skin may cause dangerous ulcers, and that workmen who handle cloth dyed with solution of chromates are apt to suffer from ulcers and eczema.

Imperial Medical Counsellor Dr. Wutzdorff published in February 13, 1896, a report called "Injuries to Health Observed in Chrome Factories, and Measures Required to Prevent Them." He reviews the literature on this subject and states that the report of the chemical works Committee of Inquiry in England, which was handed to Home Secretary Asquith in 1893, states that perforation of the nasal septum is frequently followed by impairment or actual loss of smell. He carefully analyzes the whole question of perforation of the septum and of all respiratory disorders. He reports many ulcers occurring in the workers of various chemical establishments. He states that the ulcers developed not only in abrasions or cracks but also in any places where chromate dust could settle and accumulate, as between the fingers and between the toes. He found no case of depressed nose. He thinks it possible that chromate may cause chronic nephritis in some cases. The diseases of the air-passages which occur seem to be secondary to the nasal affection, but perhaps they may also be directly due to the elimination of chromate salts through the air-passages. He notes a case where a 5 per cent. solution of chromic acid was used for excessive perspiration of the feet. Violent dermatitis, with symptoms of chrome poisoning, followed. Among other regions in which ulcers have been reported he notes the external ear and the eyelids. He found no ulcer that reached a tendon or a joint. It was said in one works that the bony septum of the nose had never been affected and that tobacco is no protection from attacks. Small number of ulcers of the mucous membrane of the palate and throat were noted in workers in one of the works. He discusses at length the causal relationship the work in manufacturing bears to health and says that the vapor arising from hot chromate solutions contains chromates. He then sets forth the procedures

to be undertaken to prevent injuries to health, insisting particularly upon the maintenance of cleanliness among the workmen and that when any chromate affection develops, the workman must be excluded from this work while the trouble lasts.

REPORT OF CASES PERSONALLY OBSERVED

One of us (Da Costa) has seen 44 cases altogether, 19 of which are here presented. Of the previous 25 there are no detailed records. Of the 44 cases, 5 worked in dye houses, 4 handled chromium hides, 2 worked in chemical works, 1 handled dyed cloth, and the balance were tanners. We are of the opinion that now and then a man who is wearing stockings containing dye fixed by chrome develops a genuine chrome ulcer of foot or toe. We have seen ulcers on the feet presenting all the ear marks of chrome ulcer and obviously due to recent local irritation, the victim never having worked in chrome. A prolonged case resembles the trophic or perforating ulcer of locomotor ataxia.

Of the 19 reported cases only 2 were Americans; the others were chiefly Italians, Austrians and Russians. This does not show any race predisposition or immunity. It simply shows how extensive is the invasion of our protected industries by foreigners. The ages were from sixteen to fifty-five. The period during which they had worked in chromates was between two months and eighteen years. Practically all the old workmen (seven cases) showed scars of previous ulcerations. One worked in chrome thirteen years and one four and a half years before developing an ulcer. The most common situation was in the folds of the dorsal surface of the fingers over or near the knuckles (Figs. 1, 2 and 3), but in one case we found ulceration on the palmar surface just below the metacarpal phalangeal joints (Fig. 4); two on the back of the hands; two on the dorsal surface of the forearm; one in the interdigital folds; one on the side of the last digit of the finger; one on the front of the knee; one at the edge of the nail (Fig. 5); one on the outer surface of the wrist; one on the back of the forearm, etc. In the old group of cases one was on the body near the groin and one on the inner surface of the prepuce. In such situations an ulcer is probably due to scratching with contaminated hands.

In practically all cases the ulcerated part had been kept wet by chromate solution. In one case several of the finger nails were lost several times in succession. The nails reformed with fair rapidity after the loss, which was quite painless. This man has no symptom of any disease of the spinal cord or nerves. In one case a finger was lost after perforation of a joint (Fig. 3).

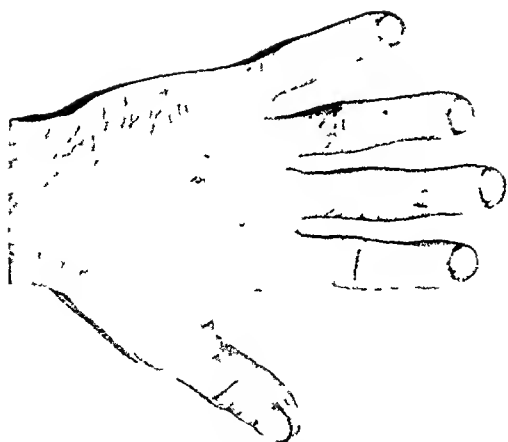


FIG. 1.—Scars of chrome ulcers.



FIG. 2.—Chrome ulcer on dorsal surface of second finger.



FIG. 3.—Amputation as the result of chrome ulcer eating into joint. Active chrome ulcer present now.



FIG. 4.—Chrome ulcer on palmar surface of ring finger, over articulation, healed ulcer on thumb.



FIG. 5.—Scar of chrome ulcer on dorsal surface of distal phalanx of second finger near nail.



FIG. 6.—Chrome ulcer of index finger over articulation.

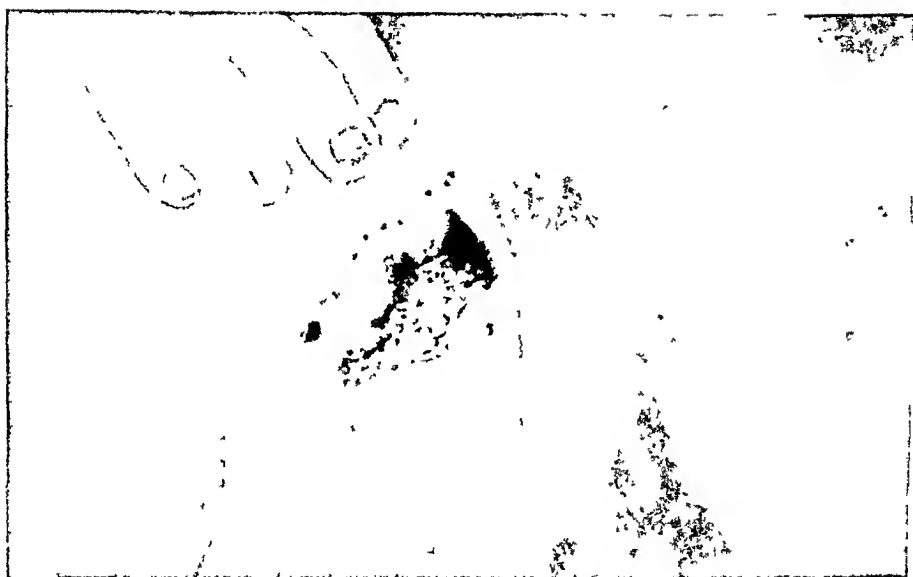


FIG. 7.—Leather worker's ulcer in region of knee area; severely infected.



52 CANTY
FIG. 8.—Leather worker's ulcer with infected finger

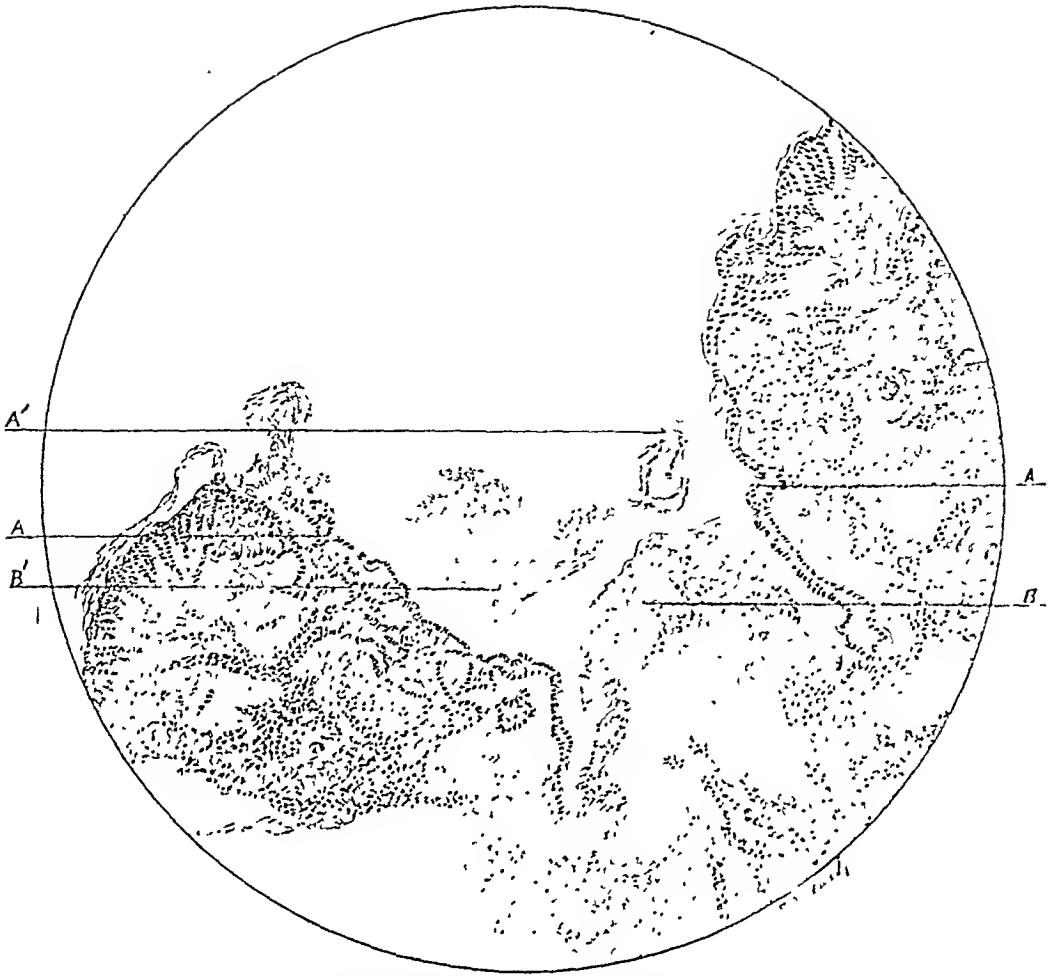


FIG. 9.—Leather worker's ulcer (chrome ulcer). *A*, *A*, walls of ulcer covered with epithelium; *A'*, island of cornified epithelium; *B*, floor of ulcer; *B'*, slough from floor of ulcer. Ulcer was 2 cm. in length, 1 cm. in width and almost 1 cm. in depth. The edges were very jagged and irregular, black in color, with induration. The floor of the ulcer was black in color, and in gross appearance contained what seemed to be masses of granulation tissue. The skin immediately adjacent to the ulcer was apparently normal, and presented areas of thickening. Sections were cut and stained with hæmatoxylin and eosin, hæmatoxylin and Van Gieson, with polychrome methylene blue; by Gram-Weigert and plain Gram technic. Histological study shows the ulcer to be clean cut and the edges lined or covered with stratified squamous epithelium. This cellular layer extends down to the floor of the ulcer and is apparently hypertrophied, as evidenced by the extensions into the connective tissue of the skin. In one area in the specimen is an isolated "island" of cornified epithelium (*A'*), evidently clipped off from a papilla of the skin. The floor of the ulcer is made up of nests of polynuclear leucocytes, areas of hemorrhage and cellular debris. Sections of sweat glands, or sebaceous glands, and of hair follicles are present, and in the immediate vicinity of these structures are accumulations of polynuclear leucocytes and some few round cells indicating a marked inflammatory condition. Irrespective of the structures above mentioned marked leucocytic infiltration is seen throughout the specimen and the blood-vessels all show marked thickening of the walls, some showing leucocytic infiltration between the coats. Recent as well as old areas of hemorrhage are present, some being immediately beneath the epithelium, while others extend down to the floor of the ulcer. When examined with the high-power objective numerous cells (leucocytes) are observed which contain pigment granules, brownish or brownish-black in color, especially in the areas of hemorrhage, while in one or two areas accumulations of these granules appear to follow minute capillary vessels. Bacteriological examination shows Gram-positive micrococci arranged in pairs and chains. No other organisms were observed. Results of inoculations from ulcers: Inoculations were made upon plain agar and into deep tubes of litmus lactose agar. These deep tubes were placed in an anaërobic condition. Of twelve cases studied, staphylococci (aureus or albus) were recovered in nine cases. Both aureus and albus were encountered in three cases. The bacillus proteus vulgaris was isolated in one case; a diphtheroid bacillus and the staphylococcus pyogenes albus in one; while the sarcina lutea and *B. megatherium* were observed in another. (These two latter cases were undoubtedly contaminations.) There was no difference in results obtained in the anaërobic condition. In one case no growth occurred.

TANNERS' ULCER

Duration of the cases we saw varied from a few days to seven months. The duration is indefinite. In fact, healing is not to be expected while the work is continued, unless the part is kept really covered by impervious gloves.

The chief characteristics of ulcers are induration, pain, and a tendency to deep penetration.

The longer the duration of the ulcer the greater the induration and the greater the ulceration. One of our cases reached a tendon, one entered a joint, and another reached the bone. Seven of these cases were single, twelve of them multiple. In several of the cases there were several ulcers and in one of the cases there were many ulcers. One case had nine ulcers. One of the cases of forearm involvement had a great number of small ulcers, apparently arising in hair follicles.

A number of writers have maintained that to develop an ulcer one must have first an abrasion, a fissure, a scratch, a wound, or a crack. The great majority of our cases presented some such antecedent condition but not all. In two of the cases the condition started in the hair follicles of the forearm, which part was frequently wet with the solution. In the one case ulceration began in the hair follicles of the dorsum of the hand. In the ulcer of the front of the knee (Fig. 7), the knee was constantly wet with the chrome solution but was not excoriated before ulceration. This ulcer became seriously infected and sloughed extensively. One started in an area of prickly heat and one began in an insect bite. The workman could always tell if the ulcer had started in an excoriation, because if there was such a break of continuity he felt severe sticking pain the moment the hand entered the chromate solution. While working, all ulcers will be violently painful. Most of them are very painful even when not working, particularly when exposed to cold, even slight cold. One of our cases kept his hands in his pockets, even in summer, to avoid draughts. Only one of our cases was free from continual pain. All are tortured by itching, especially at night. The patients are usually oscillating between the Scylla of pain and the Charybdis of itching. Warmth aggravates itching and cold, pain. Pain may be so severe as to seriously interfere with sleep. It is a burning pain with violent exacerbations. The ulcer will never heal while the man is working, if he does not wear rubber gloves, and it may last months or years. It usually takes weeks to heal even when work is stopped.

As previously stated, the ulcer usually begins in an excoriation, but this is not the invariable rule, as it may start in hair follicles or in an area of skin infection, for instance, eczema, acne, or in an area of

prickly heat. The ulcer is usually circular in shape, but, if it starts in a wound or fissure, has the shape of that breach in continuity. Its characteristic features are pain, induration and deep penetration. A raw, painful and tender spot is noted which enlarges little, if at all, laterally but which deepens day by day and becomes surrounded by a wide zone of induration. The ulcer may be a mere speck, may be a quarter or a half inch in diameter, or in exceptional cases, when severe pyogenic infection occurs, as large as the one shown on the knee in Fig. 7. A green or grayish core or slough forms in the centre. This becomes loose at the sides and becomes movable from side to side but long remains attached in the depths. In the deeper cases it is attached to a tendon sheath or to the periosteum. The ulcerated area with its surrounding induration moves with the skin until the ulcer reaches tendon sheath or bone and it then becomes fixed.

We had no case of perforation through a hand or forearm such as the early writers speak of as occurring in chemical works, but we have had one case of perforation into the second phalangeal joint of the ring finger of the right hand, which caused the loss of the finger (Fig. 3).

When the slough separates the discharge lessens and the healing begins from the periphery. During healing the edges seem to shrink and to reach a lower level than the ulcer or than the exuberant granulations which sometimes protrude from the sore. An ulcer may make abortive attempts to heal. It may heal on the top so that a cavity remains in the indurated area, a cavity which is roofed in and contains seropus. This may occur over and over again. The formation of a crust is usually an indication that healing is beginning. The workmen all regard it as having this significance. The edges of the ulcer are usually perpendicular and remain so unless severe pyogenic infection arises. In nearly all cases the parts about the ulcer are densely hard. This indurated area is seldom narrow. It is usually one-eighth of an inch broad or even more. If the ulcer is not very deep the indurated area moves with the skin. The more superficial the ulcer the more movable it is and the less the induration. The deeper the ulcer the less movable it is and the greater the induration. When the ulcer extends to tendon sheath or periosteum it is entirely fixed.

The floor of the ulcer is pale pink or pale gray. It shows no granulations until the slough is loose or separated. The discharge is usually thin, scanty and purulent; being commonly yellow in color, but sometimes colorless. In some ulcers there is practically no discharge observed on dressings. A little can always be found by squeezing. In one case of severe infection there was a profuse watery discharge.

TANNERS' ULCER

The area around the ulcer is usually markedly red for a short distance and may be œdematous (Fig. 8). Some cases are bright red for a quarter of an inch about the ulcer. This means that the ulcer is not healing. The parts near about a healing ulcer are pearly white. It is not unusual to find eczema in this region. The scar which forms eventually becomes soft and loses much of its hardness as time goes on. It becomes markedly depressed, is not tender and, though first of a brownish hue, becomes pearl white. It is usually smooth but may be corrugated. In only one of our cases was there marked swelling of the hand. In this case there was cellulitis. The hand was greatly swollen and red lines of lymphangitis showed on the forearm and arm. This was the one case in which related glands were involved. In no case were there any constitutional symptoms to suggest general poisoning by chrome, and in no case were there signs of perforation of the nasal septum, ulceration of the larynx or respiratory disturbances.

Fig. 9 shows a microscopical study of a chrome ulcer and the legend contains the bacteriological report by C. Rosenberger and his description of the ulcer.

The workmen adopt various means to prevent these chrome sores when they have any excoriations upon the hands. Some wear finger tips of rubber, some apply waterproof court plaster, some apply collodion, some rub their hands with oil before putting them in the chrome salt, some wash them in a solution of carbonate of sodium on ceasing work. As a general thing the workmen use some salve for the abrasions but some workers maintain that any ointment does harm. It has been my custom to treat the cases during the progressive stage by washing them first with carbonate of sodium and then several times a day with peroxide of hydrogen and dressing them with lead water and laudanum.

Hot-water bags are used for pain. Soaking in hot lead water gives relief. Surgical removal of the slough does harm. The manufacturers maintain that the condition will seldom arise if the workman is careful to clean his hands and that he will have no severe trouble if he will stop work when he has an abrasion. Many of them dwell on the notorious carelessness of workmen. One manufacturer wrote me that oiled hands were a great protection. He also stated that similar sores occur from hydrochloric acid, from lime and from sulphide of sodium, and says that carbonate of soda has long been recommended as a wash for chrome stings.

Isaac Tyson, of Baltimore, recommended that the sore be painted once with a solution of nitrate of silver in order to form insoluble

chromate of silver. Chevalier, Sr., and Bécourt recommended dressing with weak lead acetate and dilute alcohol and have stated that soaking in dilute lead water for four or five minutes will relieve pain and enable the patient to get sleep.

We have received the following important communication as to the prevention of chrome sores among tannery workers. It was sent us by Dr. Louis Levi, Chief Chemist to the Pfister and Vogel Leather Company, Milwaukee, U. S. A. He says that chrome sores tend to become very painful and eat very deeply. He has tried all kinds of alkaline and neutral ointments for the cure of this disease and without success. He therefore determined to try and find some means of prevention. He has prepared a very efficient ointment which he has now been using for a year and the cases have dropped from four to six a week to two in six months.

He orders that the ointment be applied twice daily. Three parts of petrolatum are mixed with one part of lanolin. This mixture is melted on a water-bath or stove and when melted and thoroughly mixed, ten to fifteen drops of 90 per cent. carbolic acid are added to every 400 grammes of the mixture. This represents five drops of acid to four grammes of ointment. The material is placed into a glass or earthenware jar and allowed to solidify until ready for use. The workman cleanses his hands and arms thoroughly with soap and water, rinses with warm water and, while the parts are still moist, applies the ointment. He rubs it over the whole exposed area for about two or three minutes. He then takes a clean cloth and wipes the skin entirely dry. Doctor Levi says that the lanolin is absorbed by the skin and that the petrolatum forms a light coating on the surface. The petrolatum will keep most of the chrome away but, should this outer coating of petrolatum wear off, the lanolin in the skin will still prevent the action of the chrome. Doctor Levi published this method in the *Hide and Leather Review*, London, England.

MULTIPLE CARTILAGINOUS EXOSTOSES (HEREDITARY DEFORMING CHONDRODYSPLASIA) *

WITH NOTES OF NINE HITHERTO UNPUBLISHED CASES

BY ASTLEY PASTON COOPER ASHHURST, M.D.
OF PHILADELPHIA

. THE clinical entity which goes under the name of multiple cartilaginous exostoses has recently been studied by Ehrenfried, who prefers the name hereditary deforming chondrodysplasia. According to Rendu and Levy its relation to chondrodysplasia was recognized by Ollier as long ago as 1899. G. G. Davis says it was described as a clinical entity by Cæsar Hawkins, in 1837. Ehrenfried found only about twelve cases which have been reported in America, the greatest number being reported from Germany and France. Inasmuch, however, as I have myself had the opportunity to see no less than eleven such patients within the last ten years it is evident that the affection is not really rare, but merely has been ignored, because there is so little that can be done in the way of treatment.

The affection is more frequent in males than in females, is distinctly hereditary, may be transmitted by both affected males and females, but there is no good evidence that it may be transmitted by unaffected males, though it may be transmitted by unaffected females (Reinicke, 1890; Lippert, 1903). The essence of the disease is not the exostoses; these are merely incidental (Lenormant, 1905). This has received especial recognition since the more common use of X-rays, but was suggested by Ollier and others long before the advent of skiagraphy. As a matter of fact, the underlying pathological change is a chondrodysplasia, affecting especially the metaphyses of the long bones, though the bones of the pelvis, the clavicles, scapulæ and the vertebræ may be involved also. In skiagraphs the bone ends may look cystic (Fig. 2), owing to irregularly distributed areas of cartilage in the metaphyses. The epiphysis itself is small or misshapen, the intermediary cartilage is narrow, irregular, oblique, or zigzag, and sometimes prematurely ossified (Lenormant, 1905). Scattered along the ends of the shaft beneath the periosteum are to be found clumps or nests of cartilage cells persisting uncalcified where they

* Read before the Philadelphia Academy of Surgery, October 4, 1915.

were left in the process of growth. Later these groups may develop into cartilaginous exostoses or chondromas (Ehrenfried, 1915).

Certain secondary characteristics usually but not always are present, and are easily recognized (Bessel Hagen, 1891). These are a low stature, due to shortness, not of the trunk, but of the limbs; as a rule the lower limbs are more shortened than the upper. There often is a lack of growth of the ulna, resulting in relative overgrowth in length of the radius, which becomes luxated at one or both ends, especially at the elbow. Thus the condition has been mistaken for "congenital dislocation of the radius," and according to Bessel Hagen most cases so described really were cases of this dyschondroplastic affection and in no sense instances of a congenital dislocation. Pes valgus is a frequent development from lack of growth of the fibula, with relative overgrowth of the tibia.

The deformities above enumerated may come before the exostoses, and the latter may never develop. Exostoses may develop in cases of very slight or insignificant deformities; or exostoses may be present on undeformed bones while the same patient may have other bones which are deformed but without exostoses.

Occasionally a malignant osteocartilaginous tumor develops in one of the exostoses. Ehrenfried says Lenormant and Lecène collected 24 such cases, and he has himself found references to about a dozen more.

Patients usually come under observation at or about puberty, for pes valgus, for painful pressure by one or more exostoses, or for general bone pains. After skeletal maturity the disease usually ceases to progress; but in the remarkable case reported by G. G. Davis (recorded below as Case 10) a man who had had exostoses since childhood began to develop new tumors when past fifty years of age, after a quiescent period of more than 30 years. In the patient recorded below as Case 8, moreover, there is no certain knowledge of the existence of the exostoses before the age of thirty years. But if we remember that exostoses are incidental features of the affection, there is no reason, so far as I can see, to deny the possibility of their appearing for the first time in adult life.

I give below a brief abstract of the cases which have been under my own observation. Unfortunately the hereditary character of the disease is not very apparent in this series, most patients denying that any other members of their family were similarly affected. But it is very likely that closer investigation might have discovered some such cases.

MULTIPLE CARTILAGINOUS EXOSTOSES

CASE I.—Ella C. M., aged four years, was referred to the Orthopædic Service of the Episcopal Hospital by Dr. Henry Winsor and Dr. James W. Ellis, September 20, 1915. This girl is her parents' only child; the mother has had no other pregnancies. The parents are both healthy, and the family history is otherwise negative. The child was normal at birth. From the age of 11 months to 20 months she suffered from enteritis, and had an intercurrent attack of measles at the age of one year. Since then she has been healthy, with the exception of an attack of varicella about three months before coming under observation.

About one year before seen by Dr. Ashhurst, the child fell and bruised her left knee. When her mother came to rub it for her she found a lump on the outer side above the knee. No further trouble was experienced, and it was not until about six or seven months later that the mother noticed similar bony lumps on the upper part of the left humerus and at the right elbow.

Examination at the present time shows a fairly well developed and nourished child, with no subjective symptoms. The mother thinks the lumps have not increased in size much if at all since they were first noticed. There are exostoses in the following locations: Two on the spine of the right scapula, one on the upper angle of the left scapula, one on the fifth right rib, near its cartilage; one on the upper end of each humerus, that on the right apparently arising from the lesser tuberosity, and that on the left from the greater tuberosity; one on the upper end of the right ulna, inner side; one above the external condyle of the left femur; one above the external malleolus of the left fibula.

The head of the right radius is unduly prominent, as if subluxated.

Many skiagraphs were taken, but as the child was very refractory and would not be still, none of them are sufficiently good to be reproduced as half-tone illustrations.

CASE II.—Philip W., twenty years old, seen in Dr. Davis's service at the Orthopædic Hospital, April 17, 1906 (Book xviii, p. 118). Exostoses first noticed at age of three months. There are now exostoses on nearly all the bones; in both forearms the radii are longer than the ulnæ, and the hands deviate to the ulnar side. There is moderate valgus in both feet.

CASE III.—Edna U., eleven years old, negress. Seen in my dispensary service at the Children's Hospital, August 13, 1907. There are four other healthy children, and so far as known no one else in family has any similar affection. No history of tuberculosis. The patient began to walk at age of nine months, and so far as family knew was perfectly normal until three years ago.

when exostoses began to appear, and have been growing larger since. She comes for pains in her bones. The photograph (Fig. 1) shows many of the exostoses. The right radius was 21 cm. in length, and the left 18.5 cm. There is some shortening of the ulnæ, and slight valgus in both feet from deformities in the leg. She was under treatment at this time for 7 months, and her pains lessened while taking the syrup of the iodide of iron. Three years later she was seen at the Orthopædic Hospital, in Dr. Davis's service, for pronounced valgus in both feet. As the condition was painful, braces were ordered including the legs.

CASE IV.—Fred R., aged seventeen years, was seen in Dr. Davis's service at the Orthopædic Hospital, November 12, 1907 (Book xx, p. 14). The family history is recorded as negative. The boy had had typhoid fever in 1897, when eight years old. About one year later he first noticed an exostosis over the upper inner end of left tibia. One year later a similar growth appeared in a corresponding situation on the right leg. Then gradually others formed all over the long bones. The left knee is markedly bowed (outward). The right lower extremity measures 88 cm., and the left 91 cm., being longer than the right in spite of the bowing of the knee.

CASE V.—Henry B., fifteen years old, was seen in Dr. Davis's service at the Orthopædic Hospital, January 21, 1908 (Book xx, p. 62). His brother, with the same affection, is recorded below as Case VI. Another brother, also said to have multiple exostoses, was not seen. Henry has had the affection for seven or eight years, and for five years had to wear leg braces on account of pain and weakness. There are exostoses on all long bones, on both clavicles, both scapulæ and on the pelvis, but none on the hands or feet.

CASE VI.—Mason B., aged thirteen years, seen in Dr. Harte's service at the Orthopædic Hospital, March 19, 1908 (Book xiii, p. 58). Two brothers have multiple exostoses. One is recorded above as Case V. Mason has noticed the present condition about two years. He comes for valgus deformity in both feet. The right leg, from knee to ankle, is 1.5 cm. shorter than the left.

CASE VII.—Herbert T., aged fourteen years, seen in Dr. Harte's service at the Orthopædic Hospital, February 11, 1909 (Book xiii, p. 215). The boy came for weakness in the left arm, which had existed for a year. There was paralysis of the left ulnar nerve, evidently due to pressure of a bony mass in the neck (Fig. 2). Over this mass there was a keloid scar from an operation performed four months previously in another hospital. So far no improvement had followed this operation. There were also exostoses of the right humerus, left femur, left tibia and



FIG. 1.—Case III. Multiple cartilaginous exostoses in a negro girl of eleven years.

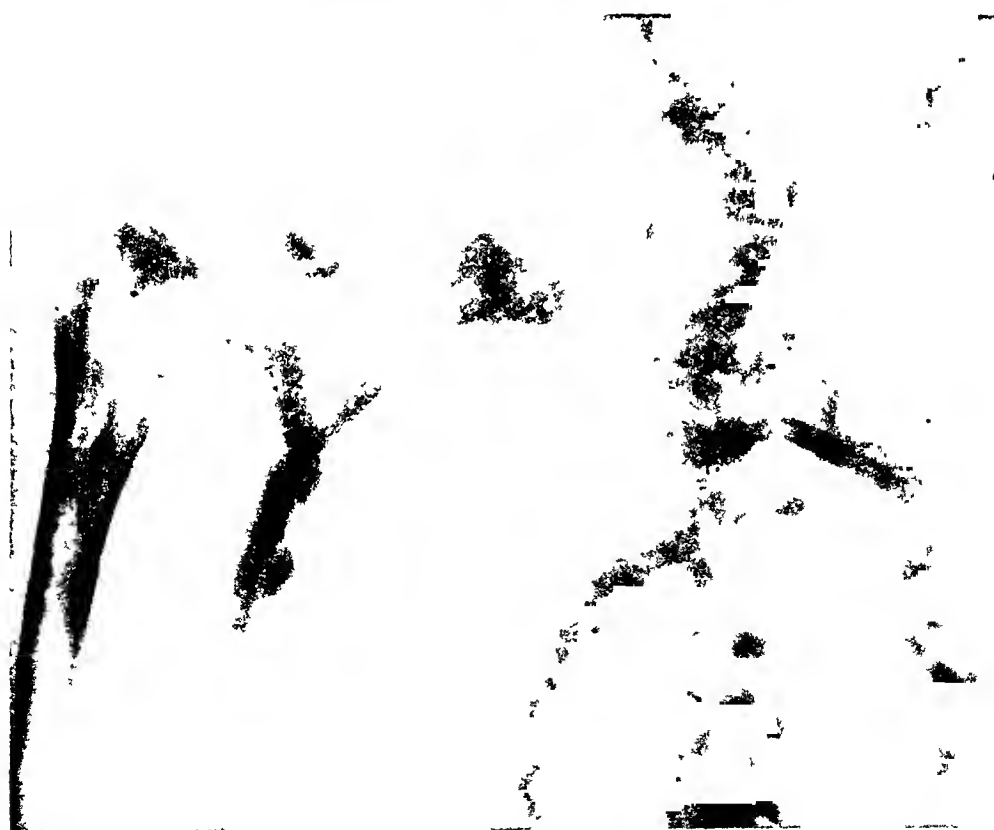


FIG. 2.—Case VII. Multiple cartilaginous exostoses. The mass in left side of neck has caused paresis of ulnar nerve. Note involvement of vertebral border of scapula, exostoses on upper end of humerus and cystic (cartilaginous) appearance of underlying bone.



FIG. 3.—Case VII. Multiple cartilaginous exostoses.



FIG. 4.—Case XIV. Exostosis above internal condyle of femur

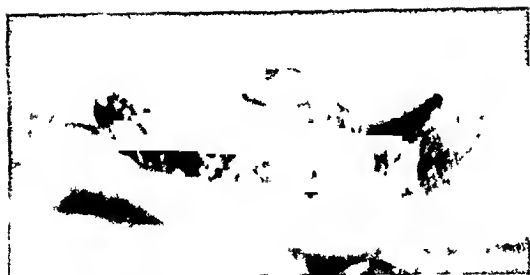


FIG. 5.—Case XV. Exostosis excised from humerus.



FIG. 6.—Case XVII. Traumatic hyperostosis of the humerus, four months after a fall on elbow.

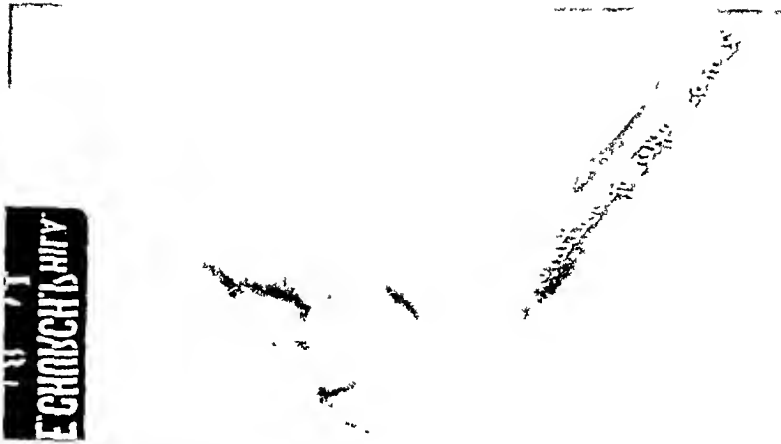


FIG. 7.—Case XVII. Recurrence of hyperostosis of humerus two months after operation.



FIG. 8.—Case XVII. Gradual absorption of new-formed bone, nine months after operation.

MULTIPLE CARTILAGINOUS EXOSTOSES

fibula. A photograph (Fig. 3) shows considerable valgus deformity in the feet, and moderate shortening of the upper extremities, and some of the lower extremities, as the midpoint of stature is not at the pubis, but half way between it and the umbilicus.

CASE VIII.—Alexander M., thirty years old, seen in Dr. Davis's service at the Orthopædic Hospital, June 8, 1909 (Book xxii, p. 19). The family history is negative. The patient had never been ill, and denies all venereal disease. The present complaint was noticed after what he calls an attack of "rheumatism" for which he says he was treated from December, 1908, to March, 1909. Until the latter date he did not know of the existence of any exostoses. At this time Dr. Davis removed an exostosis from the left femur, which was pressing on the sciatic nerve (possibly the cause of his "rheumatism" during the winter), and one from the left fibula.

CASE IX.—Mary R. B., aged seven years, seen in Dr. Davis's service at the Orthopædic Hospital, August 10, 1909 (Book xxii, p. 84). The exostoses were noticed before the child was one year of age. They are present on all four extremities, on the scapulæ, and one is forming on the left ribs. The child was brought for pronated feet.

I have also seen the two patients reported by Dr. Davis in the monograph already mentioned:

CASE X.—A man, aged fifty-three years, whose exostoses began to appear when he was about ten years old. After the age of fifteen or sixteen years, the disease became more or less stationary, except for gradual impairment of joint motions. At the age of fifty-two years an exostosis developed on the left ramus of the pubis; this growth subsequently grew smaller while the patient was under Dr. Davis's observation. The man suffered from considerable pain in his bones, and was incapacitated for work. A photograph published by Dr. Davis, as well as numerous skiagraphs, shows the typical deformities characteristic of the disease, namely, relative shortening of ulnæ, with ulnar deviation of the hands, and subluxation of the head of the left radius; right knock-knee, and valgus in both feet.

CASE XI.—A child (sex not recorded) aged three years, with multiple exostoses, which were first recognized by the mother before the child was one year old. The digital phalanges were involved as well as all the long bones of the limbs. The child also was rhachitic, and knock-knees were present.

There are also brief records at the Orthopædic Hospital of the following two patients, in Dr. W. J. Taylor's service. They did not come under my personal observation:

CASE XII.—Edward S., aged sixteen years, January 26, 1907 (Book xiii, p. 12). Has had knock-knee since childhood; had typhoid fever 4 years ago. Has several exostoses on or near each knee.

CASE XIII.—Hugh McN., aged thirty-four years, March 5, 1910 (Book xv, p. 31). Has presented symptoms due to exostoses for 2 years. Exostoses are present at right wrist, left elbow, and left scapula.

Owing to lack of details it is not certain that these cases (XII and XIII) are instances of hereditary deforming chondrodysplasia. But the more one looks into the matter, the more difficult does it become to draw any definite lines between well defined "typical" cases and those which are just on the verge of typical. At the other end of the scale come those patients who present one or at most two or three exostoses, which have developed without any evident cause, or have been discovered after a slight injury which may or may not have been an etiological factor. These patients present no indication of any hereditary affection, and no skeletal deformities are noticed. It is of course possible that in such cases a thorough skiagraphic examination might reveal evidences of chondrodysplasia in bones showing no other evidences of disease, or might even show other insignificant exostoses.

The following cases, for instance, are to my mind examples of chondrodysplasia of some sort:

CASE XIV.—Annie S., aged sixteen years, was seen in Dr. Harte's service at the Orthopædic Hospital, July 27, 1911. Two years previously she had struck her left thigh against the runner of a sled, and three months later a bony lump appeared. She complained of pain in the lower part of her left thigh when walking. The lump was a typical cancellous exostosis, springing from the femur above the internal condyle (Fig. 4), and I excised it with the cortex from which it sprang, September 7, 1911.

CASE XV.—Jennie F., aged thirteen years, referred to my service at the Episcopal Hospital by Dr. R. S. Hooker, in May, 1914. A bony lump had been noticed at the right shoulder for three weeks; there was no history of injury. The exostosis, springing from the humerus and presenting beneath the anterior fibres of the deltoid muscle, was excised with the underlying cortex, May 13, 1914 (Fig. 5). There has been no recurrence to date.

CASE XVI.—Grace J., aged fourteen years, came to my service at the Orthopædic Hospital, October 31, 1914. About September 1, 1914, she had fallen on the stairs, and twisted her shoulder in the banisters. About a month later she noticed a lump on the right scapula. This caused pain, and seemed to be growing larger. On December 12, 1914, I excised it. It sprang from the upper vertebral angle, and the portion of bone from

MULTIPLE CARTILAGINOUS EXOSTOSES

which it grew was removed in one piece with it, including the entire thickness of the scapula. Recovery was uneventful. About four months later the girl returned, complaining of neuralgic pains beneath the right pectoralis minor, and shooting back to the scapula. Skiagraphs showed no bony lesion. The girl was referred to the nervous department of the hospital for an opinion, and Dr. F. W. Sinkler reported that he considered her neurasthenic. At all events she recovered from her pains without further surgical treatment.

Two utterly different types of cases, it seems to me, are those recorded by me in the remaining pages of this article—one a traumatic hyperostosis, the other an instance of osteophytes accompanying chronic hypertrophic arthritis.

CASE XVII.—Traumatic hyperostosis of the left humerus, recurring after operation, but eventually disappearing spontaneously.

Mary D., aged twenty-four years, was seen in the Orthopaedic Service of the Episcopal Hospital, June 1, 1914. Four months previously she had fallen down ten steps, landing on her left elbow. Her physician said it was dislocated, but an X-ray showed no bone lesion. It was bandaged for some weeks, but remained painful.

When examined at the Episcopal Hospital, four months after the accident, there was marked disability, with constant pain in and above the elbow. There was full extension and normal rotation, but flexion of the elbow was stopped by bony contact at 80 degrees. A bony mass could be felt in the flexure of the elbow a little to the median side of the midline between the condyles. An X-ray showed a mass of bone in the flexure of the elbow (Fig. 6) apparently arising from the humerus, possibly from the muscle. The patient readily consented to have the excessive bone removed by operation, as she was unable to do her work (house-work).

*Operation (June 29, 1914).—*Under Esmarch anæmia a longitudinal incision was made along the median edge of the biceps muscle, displacing the brachial vessels and median nerve to the median side. This gave ready access to the growth, which, as shown by the X-ray, sprang from the humerus, nearer its median than its lateral border. The growth extended down to the trochlear surface. It was covered by periosteum which appeared normal, and did not in any way involve the muscles. The mass with its overlying periosteum was removed by gouge and mallet, until the normal contours of the humerus were restored, and normal flexion of the elbow was possible.

The pathological report, by Dr. C. Y. White, Director of the Pathological Laboratories of the Hospital, stated that the specimen was composed of cancellous bone containing areas of granulation tissue.

July 20: Elbow flexes further than before operation. A bony mass is still felt over the lower anterior part of the humerus.

August 3: Flexion to 65 degrees and full extension.

August 31: Flexion to 60 degrees. Some pain in damp weather.

X-ray shows recurrence of bony growth in flexure of elbow (Fig. 7).

March 8, 1915. Nine months after operation. Flexion to 50 degrees, extension normal. Never any pain or disability. X-ray shows scarcely any thickening of the shaft at the site of the former hyperostosis (Fig. 8).

CASE XVIII.—*Osteophytes of humerus, accompanying chronic arthritis of the shoulder; excision with permanent relief of symptoms.*

John C., aged sixty-two years, broom-maker. Blind since age of twelve years, as the result, he says, of an attack of typhus fever. He was seen in the Orthopædic Service of the Episcopal Hospital, August 5, 1913. About 15 years previously he had fallen and injured his right shoulder, and it had given him constant discomfort since. In December, 1912, this shoulder gave a sudden crack while at his work of making brooms, and he had been unable to work at all subsequently until the present, on account of the pain in his shoulder on any motion.

Examination showed a well-preserved but thin old man, not at all robust. There was no limit to passive motion in the shoulder-joint, but very marked crackling on external rotation and very great tenderness over the tuberosities. On elevation of the arm the tender points disappeared under the acromion. A skiagraph showed no bony lesions other than some hypertrophic changes in the acromioclavicular joint, where he had no symptoms. Operation was undertaken as an exploration, in the expectation of finding some peri-arthritis with bursal adhesions.

Operation (August 15, 1913).—Ether. An incision from the point of the acromion downward for three inches was made, splitting the anterior fibres of the deltoid. No evidence of any subdeltoid bursa was found. Immediately beneath the deltoid the very thin capsule of the shoulder-joint was exposed, and on opening this the head of the humerus was found to be eroded and flattened. The external part of the head was much flattened, and there were two osteophytes at the margin of the articular cartilage (just at the reflection of the capsule on to the ana-

MULTIPLE CARTILAGINOUS EXOSTOSES

tomical neck), which caught on the capsule during rotation outward, and caused a distinct *jump* and crackling. These two osteophytes were removed by gouge. They were about 6 or 7 mm. high. The long head of the biceps, on the inner side of the incision, seemed to be intact.

Pathological Report (Dr. C. Y. White).—Compact bone, denser than normal, covered with cartilage on its free surface. No evidence of inflammation.

The subsequent history is brief and satisfactory. The wound healed promptly, all pain was relieved, and the man returned to his work. He was last seen September 6, 1915, more than two years since operation. He has not had a pain or a twinge in that shoulder since operation, and continues his work without disability, except that he is now developing a Dupuytren's contracture in the palm of the right hand.

REFERENCES

- Bessel Hagen: Arch. f. klin. Chir., 1891, xli, 420.
Davis, G. G.: Amer. Jour. Orthop. Surg., 1905-1906, iii, 234.
Ehrenfried: Jour. Amer. Med. Assoc., 1915, i, 1642.
Lenormant: Revue d'Orthop., 1905, xvi, 193.
Lippert: Deutsch. Arch. f. klin. Med., 1903, lxxvi, 63.
Reinicke: Beitr. z. klin. Chir., 1890, vii, 657.
Rendu and Levy: Lyon Chir., 1914, xii, 164.

TREATMENT OF VARICOSE LEG ULCERS*

BY PENN G. SKILLERN, JR., M.D.

OF PHILADELPHIA

VARICOSE leg ulcers belong to that class of maladies for the cure of which a host of therapeutic measures is recommended. The purpose of this paper is to show both the fallacy and the futility of expecting a cure of varicose leg ulcers by drug therapy alone, and to prove that the most efficient therapeutic measure is the *vis medicatrix naturæ*.

Varicose veins are a penalty of the upright position. Reduced to its simplest terms, the pathology is primarily that of chronic venous congestion, mechanical in origin. This simple etiologic factor underlies all the secondary effects, such as ulceration, infection, fibrosis and bone involvement.

The rational treatment of varicose leg ulcers, then, must be based upon measures that combat the phenomena attendant upon chronic venous congestion, namely, transudation of serum and migration of blood-cells into the connective-tissue interspaces, and the inevitable fibrotic thickening of the walls of the connective-tissue interspaces.

Reduced to its simplest terms, the rational treatment of varicose leg ulcers, based on their pathology, depends upon the recognition and application of the principles of, first, protection, second, drainage, and, third, support.

(1) *Protection*.—Any ulcer is cured when epithelialization of its entire surface is complete. Epithelialization of the ulcer surface will not occur in the presence of an unhealthy ulcer base. The ulcer base is made healthy by affording drainage of the matter discharged from it and by giving it proper support. With the ulcer properly drained and supported the epithelium at the margin of the ulcer begins to regenerate. Because of its delicacy of texture and superficial position, this regenerating epithelium requires protection, lest it be torn away during the change of dressings. The best protective agent is a material that has a perfectly smooth surface. Such a protective agent is rubber tissue. When the ulcer is large its epithelial edge may be efficiently protected by being covered with strips of rubber tissue cut to about one-fourth inch in width (Fig. 2). When the ulcer is small a piece of rubber tissue may be cut to the size of the ulcer and a hole made in the centre of the

* Read before the Philadelphia Academy of Surgery, October 4, 1915.

piece of tissue to afford an outlet for the discharge from the ulcer into the superposed dressing. If no outlet be provided, this discharge accumulates beneath the rubber tissue and most effectively macerates the regenerating epithelial edge. This macerating action constitutes a valid objection to the no-drainage method of smothering the ulcer with an impervious unguent dressing.

(2) *Drainage*.—As just stated, provision for the escape of the discharge from the ulcer is made by cutting a hole in the centre of the piece of protective rubber tissue. The amount of discharge will lessen as the œdema of the tissues subsides from the pressure of the bandage.

What is the best form of dressing to take up the discharge from the ulcer? The tissues are already more or less water-logged, so why apply a wet dressing? A wet dressing does not remain wet very long unless evaporation of its contained fluid be prevented by such an impervious material as paraffin paper or oiled silk. But a wet dressing covered by an impervious material merely increases the maceration of the already macerated tissues, and, furthermore, it is impracticable for the patient to keep the leg dressing moist until the time of the next visit.

Plain, dry, sterile gauze admirably meets the requirements of a dressing that will take up the discharge without increasing the water-content of the tissues. It may be objected that dry gauze placed in direct contact with a granulating surface would act as a mechanical hindrance to the granulations by their becoming adherent to it and growing into it, so that at the change of dressings the granulations would be traumatized by removal of the gauze. Practically, however, the granulations do not become adherent to the gauze owing to the slimy character of the discharge from the ulcer. The only place where the gauze could become adherent is at the epithelial edge of the ulcer, but the epithelial edge is already protected by the rubber tissue. When the dressing is removed it comes away freely without sticking at any spot.

(3) *Support*.—It is a well-known clinical fact that the very best treatment of varicose leg ulcers is by the non-ambulatory method, of rest in bed with elevation of the limb involved. The explanation of the superiority of the method of rest in bed with elevation is, of course, that the chief etiologic factor in the development of varicose veins—the attraction of gravity for the long column of blood in the saphena magna—is overcome; the œdema of the tissues subsides, and with the subsidence of the œdema the nutritional state of the tissues is improved, and improvement of the nutritional state enhances the power of tissue repair. But few patients, however, can afford to take to bed on account

of a leg ulcer. We are forced, therefore, to combine with the ambulatory treatment the advantages of the non-ambulatory.

The best substitute for rest in bed with elevation is support of the limb; the best method of supporting the limb during the active treatment of large or multiple leg ulcers is by the application of a roller bandage, not of gauze, but of muslin; and the best type of bandage to apply is the spica, or figure-of-eight of the leg.

While commonly used, yet gauze bandages do not support the tissues as firmly as muslin bandages support them, and gauze bandages have a tendency to roll up and become disarranged. The spiral reverse bandage of the leg, advocated by some, looks prettier in the text-books than upon a patient's leg. In everyday practice a spiral reverse bandage cannot be applied upon an inverted cone, such as the leg below the calf represents, and be expected to remain in place for forty-eight, or twenty-four, or even six hours, however long the patient may be up and about.

Given one or two ulcers of limited size where healing is delayed by induration at the base and periphery of the ulcer, and provided that the skin is healthy, there is no better method to effect epithelialization than that suggested so long ago as 1792, by Thomas Baynton, of Bristol, namely, firm strapping of the ulcer by imbricated lengths of adhesive plaster applied from below upward and encircling the limb for two-thirds of its circumference (Fig. 1). When treatment was begun upon these ulcers they were indolent and sluggishly inactive, and had been for several weeks. The sketch shows the improvement after a week's strapping: from being indolent and sluggishly inactive the ulcers were transformed into healthy, rapidly epithelializing and granulating wounds, the contrast between the pure blood-red and firm granulations and the broad, bluish-white band of rapidly regenerating epithelium being so striking as to merit reproduction in tints. It is my practice to fill the excavation of the ulcer flush with the skin with a powder before applying the straps of adhesive plaster, and for this purpose I have found calomel the most useful powder. The powder serves as an agent for transmitting the pressure and support of the adhesive straps to the floor of the ulcer; without powder the straps would merely bridge across the excavation of the ulcer.

The striking efficiency of the strapping method is purely in keeping with the old surgical principle that pressure upon tissues promotes absorption of fluids and, later on, atrophy of the tissues themselves. As the induration at the base and edges of the ulcer melts away under the influence of the pressure exerted by the straps, the blood-channels



FIG. 1.—Indolent ulcers converted into the classic healing variety by the ealomet-adhesive-plaster method. Note firm, bright red granulations and encircling broad band of bluish-white, rapidly regenerating epithelium. Straps curled back for sketch. Author's case (*International Clinics*, 1913, vol. iii, 23d series, p. 210).



FIG. 2.—Photograph of multiple varicose leg ulcers taken at beginning of the treatment. Note protection of epithelial edges, by strips of rubber tape.

TREATMENT OF VARICOSE LEG ULCERS

are opened up, and instead of there being an excess of venous over arterial blood, the proper proportion is restored by the venous blood being permitted egress from the ulcer, and the healing arterial blood ingress into the ulcer.

For the routine treatment of the average varicose leg ulcer nothing serves better—nor is there any more economical form of support—than Unna's zinc oxide and gelatin paste enmeshed in a gauze bandage so as to form a stocking with the consistency of rubber. Upon the patient's return the Unna stocking is fenestrated at the site of the ulcer, as indicated by the area of staining from the discharge. In addition to fenestrating the stocking, it is my practice to cut the edge of the fenestration in a spoke-like manner, to prevent congestion of the ulcer from the edge of the fenestration pressing into the edge of the ulcer. I have seen many ulcers change from a livid to a rosy hue by merely making these spoke-like incisions into the edge of the fenestration. After the ulcer has been uncovered by fenestration of the stocking in this manner, it is treated by the rubber-tissue-dry-gauze-muslin bandage method described above. Unless it become loose, or very much soiled, the Unna stocking need not be changed for three weeks.

After varicose leg ulcers have been cured, it is important immediately to institute prophylactic methods against recurrence; and for this purpose a well-fitting silk-elastic stocking or a Randolph bandage should be used. Patients should be reminded that in the course of time a silk-elastic stocking wears out and loses its power of supporting the tissues, and that for this reason a new stocking must be purchased at intervals.

To prove the efficiency of the purely mechanical *vs.* the medicament treatment of varicose leg ulcers, I decided to put my method to a severe test by selecting the most extensive case of varicose leg ulcer that I could find. Accordingly, three weeks ago, I began treatment upon a patient whose legs were the seat of chronic multiple leg ulcers. This patient, a man aged seventy-five years, had had the ulcerous condition for about a quarter of a century, and during that extent of time recurrences had been numerous. He reported in the Surgical Clinic of Professor Morris Booth Miller, at the Philadelphia Polyclinic Hospital. From being indolent and sluggishly inactive (Fig. 2), now, after only three weeks of mechanical treatment, the bases of the ulcers are covered with healthy, red, vigorous granulations, while the epithelial edges are bluish-white and rapidly regenerating. When ulcers assume these healthy tints they never fail to heal. The complete epithelialization of some of the smaller ulcers indicates that there has already been established

a tendency to vigorous healing, and that with time and a little patience, complete epithelialization of the largest ulcer may be predicted with certainty unless the ulcer is adherent to bone.

NOTE (January 12, 1916).—Under the above-described treatment the smaller ulcers healed rapidly so that, the skin now being intact, the calomel-adhesive-plaster method was substituted, with a view to curing the two large ulcers, one on each leg. By this method the amount of discharge rapidly diminished, the ulcers quickly assumed the appearance shown in Fig. 1, and the area occupied by the ulcers became markedly decreased.

At present, owing to the adherence of their base to the bone, these two large ulcers, while healthy, seem to have reached a stationary stage in healing; all that is needed for completion of the process of epithelialization is the stimulus afforded by a few Thiersch grafts, which will be applied forthwith. Were it not for the vigorous granulations already covering the bone, the suggestion of C. H. Mayo ("The Preparation of Dry Bony Areas for Skin Grafting," *ANNALS OF SURGERY*, September, 1914, p. 372) could well be applied in this case.

For an exhaustive paper on other aspects of varicose leg ulcers, consult article by Williams (*British Medical Journal*, July, 1913).

CONCLUSIONS

1. The rationale of treating varicose leg ulcers is to establish a tendency to heal by combating the pathologic hindrances to healing.

2. The pathologic hindrances to healing are the sequelæ of chronic venous congestion; and chronic venous congestion, in its turn, is the result of the inability of the vena saphena magna and its tributaries to withstand the attraction of gravity upon the long column of blood contained therein.

3. Reduced to its simplest terms, the rational treatment of varicose leg ulcers depends upon the recognition and application of the principles of, first, protection of the regenerating epithelial edge, second, drainage of the discharge from the ulcer and, third, support of the venous channels from without, thus neutralizing the baneful effects of chronic venous congestion.

4. The agents employed in the rational or drugless treatment of varicose leg ulcers may be summarized by terming the method the rubber-tissue-dry-gauze-muslin bandage method. In selected cases the calomel-adhesive-plaster strapping method cures rapidly and efficiently; while for routine treatment of the average case Unna's zinc-oxide-gelatin paste stocking serves as an admirable and efficient support.

TREATMENT OF VARICOSE LEG ULCERS

5. The tendency to healing has been established when the base of the ulcer is covered with healthy, red, vigorous granulations, and when the epithelial edge becomes broader and assumes a pale, bluish-white tint.

6. If in a case of multiple varicose leg ulcers the smallest ulcers become completely covered with epithelium under the influence of treatment, it has thereby been proven that a tendency to healing has been established, and that in time the larger ulcers will heal, if not too large, excessively fibrosed, or adherent to bone.

7. Healing of the ulcers having been brought about, it remains to prevent recurrences. Recurrences may be prevented by mechanical or operative methods: mechanically, by the use of a silk-elastic stocking, renewed when worn out, or by a Randolph bandage; and barking of the shin should be insured against by a shin-guard or wool padding of that part of the stocking that covers the shin. If an operation for excision of varicose veins augurs favorably, it should be performed after healing of the ulcer has taken place; otherwise, the operative wound might become infected from the ulcer, and septic thrombophlebitis, with all the attendant dangers of embolism, might then ensue.

8. The success of the rational, drugless, or mechanical treatment proves the fallacy, as well as the futility, of expecting cure from the application of medicaments, while overlooking the fundamental pathologic etiology of the ulcer.

9. Fads, such as scarlet red and basic fuchsin ointments, do not promote epithelialization of an ulcer without due regard for the pathologic etiology of the ulcer, and when regard for this factor has been taken into account, the use of such stimulants is unnecessary.

THE ARTIFICIAL PERIOSTEUM FOR FIXATION OF SHAFT FRACTURES*

By JOHN B. ROBERTS, M.D.

PROFESSOR OF SURGERY

(Note from the Surgical Laboratory of the Philadelphia Polyclinic.)

THE ease with which subperiosteal fractures are cured with little callus and slight deformity is nature's hint as to treatment. Surgeons have been misled into thinking that the essential factor in treatment is absolute immobility of the jagged bone ends. Therefore, prolonged immobility by means of external splints or direct fixation by plates has successively been the vogue.

When the periosteum is little torn or only slightly stripped from the bone's shaft, reduction of the fragments and retention of the broken surfaces in apposition are easy of attainment. Successful reconstruction of the skeleton follows readily. What shall be done, however, under reverse conditions, namely, greatly lacerated periosteum, consequent wide separation of fragments, and, perhaps, entanglement of the jagged pieces of bone in muscles and fasciæ? Inspect the broken bone, repair the periosteum or provide a new periosteum, and give stability and rigidity by means of traction and contour-fitting splints.

The only way to repair the torn periosteum is to expose the broken bone by aseptic incision, adjust the ends of the fragments, and stitch the ruptured fibrous covering around the break. Often a firm repair of the periosteum in this way is not possible. Why not then substitute a graft of the fascia lata, cut from the outer surface of the patient's thigh; and, by wrapping it around the shaft of the bone at the seat of the break, prevent lateral displacement or overriding? The operative wound should then be closed without drainage and a gypsum encasement, with or without continuous traction, be adjusted to the limb.

This method I believe will be found a valuable improvement over the plating of rebellious fractures of the shafts of long bones. I have only experimented with fascial tubes or straps for this purpose on the cadaver.

The success of D. C. Straus¹ with woven catgut rugs or splints in treating experimental fractures in dogs has, however, convinced me of the value of his method of support. The autogenous fascial graft is

* Read before the Philadelphia Academy of Surgery, November 1, 1915.

¹ Surgery, Gynecology and Obstetrics, October, 1914, p. 410.

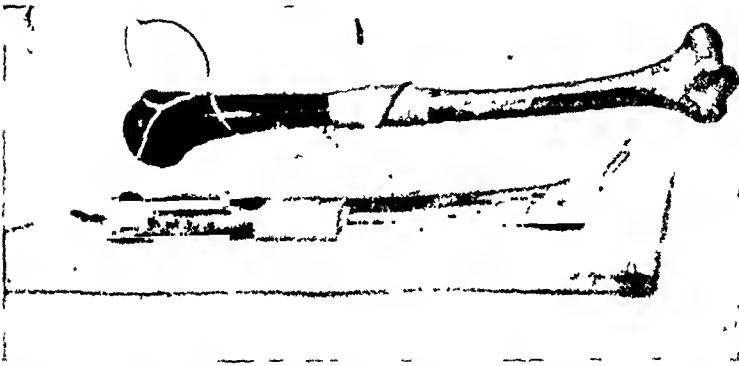


FIG. 1.—Model of fracture of humerus supported by an autogenous tubular sheath of fascia lata acting as an artificial periosteum. At the upper end of the humerus is seen the flat curved needle and catgut thread, by which the sheet of fascia has been carried around the broken bone after the fracture has been made accessible by incision of soft tissues. Bones of forearm showing fracture of ulna supported by a fascial wrapping representing an autogenous artificial periosteum.



ARTIFICIAL PERIOSTEUM IN SHAFT FRACTURES

founded on the same mechanical principle, which is that a firmly placed tube or wrapping of flexible tissue around a broken rod or bone prevents displacement.

Macewen has insisted that the periosteum does not generate bone, but merely limits its growth. If this be true, placing a new fibrous envelope, instead of the lacerated fibrous periosteum, around the ruptured osseous tissue restores in some degree the normal status of the injured bone. A long piece of fascia lata wrapped twice about the replaced fragments will, if firmly bound by sutures of fascia or of catgut or tied by strings of the same absorbable material, prevent shortening, alteration by rotation and lateral displacement. Later it will either be absorbed or converted into a sheet of fibrous tissue similar, mechanically at least, to periosteum. Normally the periosteum gives toughness and elasticity to the bone. The fascial envelope acts somewhat in a similar manner.

Thus the fascial tube is, I believe, preferable to metal plates. In comminuted fractures of the shaft it would seem to be greatly superior mechanically to plates, screws, nails, inlay grafts, or bone pegs. Straus's catgut mat was absorbed in dogs in three weeks. It is possible that stomach wall or bladder wall of the lower animals or real parchment might be used instead of the patient's own fascia lata. My experience with autoplasmic grafts, however, and the ease with which a long strip of fascia lata can be taken aseptically from a patient's thigh, without real risk to him, cause me to prefer its use.

It is possible that other surgeons have suggested fascial tubes or straps for steadying or fixing fractures requiring open or blood-letting treatment. If so, I have not heard of their experiments or experience. I should be glad to hear reports from the Fellows of the Academy, if they adopt the procedure for cases to which it seems applicable.

There have been various endeavors to obtain absorbable fixation appliances instead of plates. This seems to be the simplest.

If there is too much flexibility at the seat of fracture after the fascial binding, one of my fracture drill-pointed nails, described before the British Medical Association at Edinburgh in 1898,² may be driven through the fascial tube into the bone ends to steady them and its shaft be allowed to protrude through the closed wound. It may be readily removed at the end of ten days or two weeks without important disturbance of the external dressings.

An artificial periosteum is adapted to fracture thus:

² Philadelphia Medical Journal, 1898, and Notes on the Modern Treatment of Fractures, D. Appleton Co., New York, 1899.

The broken bone is exposed and freed from muscles for two or more inches. The fascial graft, cut from the outer aspect of the thigh, should be six or more inches long. One end should be pointed. To this pointed end should be tied, or sewed with catgut or fascia, a cord of thick catgut or Kangaroo tendon or a band of fascia. This cord should be threaded into a very large, flat, curved needle, like that used to carry a Gigli or chain saw around a bone. By means of the needle it is easy to draw the fascial graft around the coapted fragments so as to wrap the bone twice or thrice. The wrapped graft is then smoothed out on the surface of the bone and the cord used to fix it close to the enclosed broken shaft. One or two stitches may be made with the needle into the layers of fascia; or another absorbable thread may be used to stitch down the end and fasten the edges of the wrapping together. The muscles are then allowed to fall into place, the fascia over the muscles is sutured and the wound closed without drainage, as in Lane's method of plating. Outside is applied a gypsum-gauze encasement with or without traction, or a simple form of splint is used to give rigidity and secure protection from injurious motion.

The use of fascia may be varied somewhat. In very oblique fractures, for instance, two quite narrow splints may be wrapped about the bone at a considerable distance from each other and, if continuous traction is used, coaptation of fragments and length of bone will be preserved.

This fascial tube, or artificial periosteum, apparently solves the problem of substituting absorbable for non-absorbable support in shaft fractures. In 1911, I prepared, on invitation from the officers of the French Congress of Surgery, a paper entitled "An American Surgeon's Opinions of the Open or Operative Treatment of Closed Fractures." As I was, however, unable to attend the meeting it was published in *Archives Internationales de Chirurgie*, vol. vi, page 62. I have not since changed my opinion that the bloodless methods of dealing with fractures ought to remain the usual choice, and that they give, in the hands of those who apply them with care, good results. This view was and is the same that was taken by Robert Jones of England in his review of the Report of the Fracture Commission of the British Medical Association, and was that of the late Professor Bardenheuer in Germany, who for years insisted upon the infrequency of blood-letting operations if fractures were treated by permanent extension. Many surgeons in America hold the same opinion. When operative attack, however, is needed I believe the fascial tube or strap will often be found to answer the purpose better than the metal plate for shaft fractures.

HOMOPLASTIC TRANSPLANTATION OF A BOILED SEGMENT OF A RADIUS

RESULT AFTER THREE AND A HALF YEARS

BY CLARENCE A. McWILLIAMS, M.D.
OF NEW YORK CITY

ASSOCIATE SURGEON TO THE PRESBYTERIAN HOSPITAL

THROUGH the kindness of Dr. George E. Brewer, of New York, I am enabled to report this case, which he operated upon at Roosevelt Hospital on January 27, 1912. The patient was a man of twenty-seven years of age, who complained of a painless lump on the flexor surface of the right forearm. Röntgenogram showed that the lower portion of the radius was involved in a tumor growth. At operation the tumor was found to be covered anteriorly by a thin shell of bone and it consisted of a spongy mass of rather soft vascular tissue, in a cavity lined by a smooth wall of dense bone. Microscopical examination showed it to be a giant-celled sarcoma. An excision of the entire lower $2\frac{3}{8}$ inches of the radius, with its periosteum, was performed and the soft parts were sewn together about the defect. Two days later an adult pistol-wound suicide was brought into the hospital and from his radius was removed a piece of bone of exactly the same length as that which had been removed. This bone was boiled for an hour and then kept in sterile salt solution for four days, when the original wound was reopened and the boiled homoplastic radius was inserted in the defect, which it accurately filled up. It was not sutured in place but simply laid in, and about it the soft parts were accurately sutured. A plaster splint was applied. The patient was followed for a year and a half and röntgenograms were taken at different periods. The graft healed in perfectly by primary union and there has never been any discharge from it. The pictures showed some honeycombing of the graft and some bowing of the forearm.

The result was supposed to have been good until the author, in his zest for bone grafting cases, located the man after some search and elicited the following röntgenogram. The hand is much radially abducted, in fact there is a well-marked dislocation of the hand on the ulna, which latter can be distinctly palpated. The function of the hand is much injured, there is almost no abduction, and flexion and extension of the wrist are slight. The grasp of the hand is very weak. The röntgenogram is very interesting. The entire graft (*D*) can be roughly divided into three sections

The broken bone is exposed and freed from muscles for two or more inches. The fascial graft, cut from the outer aspect of the thigh, should be six or more inches long. One end should be pointed. To this pointed end should be tied, or sewed with catgut or fascia, a cord of thick catgut or Kangaroo tendon or a band of fascia. This cord should be threaded into a very large, flat, curved needle, like that used to carry a Gigli or chain saw around a bone. By means of the needle it is easy to draw the fascial graft around the coapted fragments so as to wrap the bone twice or thrice. The wrapped graft is then smoothed out on the surface of the bone and the cord used to fix it close to the enclosed broken shaft. One or two stitches may be made with the needle into the layers of fascia; or another absorbable thread may be used to stitch down the end and fasten the edges of the wrapping together. The muscles are then allowed to fall into place, the fascia over the muscles is sutured and the wound closed without drainage, as in Lane's method of plating. Outside is applied a gypsum-gauze encasement with or without traction, or a simple form of splint is used to give rigidity and secure protection from injurious motion.

The use of fascia may be varied somewhat. In very oblique fractures, for instance, two quite narrow splints may be wrapped about the bone at a considerable distance from each other and, if continuous traction is used, coaptation of fragments and length of bone will be preserved.

This fascial tube, or artificial periosteum, apparently solves the problem of substituting absorbable for non-absorbable support in shaft fractures. In 1911, I prepared, on invitation from the officers of the French Congress of Surgery, a paper entitled "An American Surgeon's Opinions of the Open or Operative Treatment of Closed Fractures." As I was, however, unable to attend the meeting it was published in *Archives Internationales de Chirurgie*, vol. vi, page 62. I have not since changed my opinion that the bloodless methods of dealing with fractures ought to remain the usual choice, and that they give, in the hands of those who apply them with care, good results. This view was and is the same that was taken by Robert Jones of England in his review of the Report of the Fracture Commission of the British Medical Association, and was that of the late Professor Bardenheuer in Germany, who for years insisted upon the infrequency of blood-letting operations if fractures were treated by permanent extension. Many surgeons in America hold the same opinion. When operative attack, however, is needed I believe the fascial tube or strap will often be found to answer the purpose better than the metal plate for shaft fractures.

HOMOPLASTIC TRANSPLANTATION OF A BOILED SEGMENT OF A RADIUS

RESULT AFTER THREE AND A HALF YEARS

BY CLARENCE A. McWILLIAMS, M.D.

OF NEW YORK CITY

ASSOCIATE SURGEON TO THE PRESBYTERIAN HOSPITAL

THROUGH the kindness of Dr. George E. Brewer, of New York, I am enabled to report this case, which he operated upon at Roosevelt Hospital on January 27, 1912. The patient was a man of twenty-seven years of age, who complained of a painless lump on the flexor surface of the right forearm. Röntgenogram showed that the lower portion of the radius was involved in a tumor growth. At operation the tumor was found to be covered anteriorly by a thin shell of bone and it consisted of a spongy mass of rather soft vascular tissue, in a cavity lined by a smooth wall of dense bone. Microscopical examination showed it to be a giant-celled sarcoma. An excision of the entire lower $2\frac{3}{8}$ inches of the radius, with its periosteum, was performed and the soft parts were sewn together about the defect. Two days later an adult pistol-wound suicide was brought into the hospital and from his radius was removed a piece of bone of exactly the same length as that which had been removed. This bone was boiled for an hour and then kept in sterile salt solution for four days, when the original wound was reopened and the boiled homoplastic radius was inserted in the defect, which it accurately filled up. It was not sutured in place but simply laid in, and about it the soft parts were accurately sutured. A plaster splint was applied. The patient was followed for a year and a half and röntgenograms were taken at different periods. The graft healed in perfectly by primary union and there has never been any discharge from it. The pictures showed some honeycombing of the graft and some bowing of the forearm.

The result was supposed to have been good until the author, in his zest for bone grafting cases, located the man after some search and elicited the following röntgenogram. The hand is much radially abducted, in fact there is a well-marked dislocation of the hand on the ulna, which latter can be distinctly palpated. The function of the hand is much injured, there is almost no abduction, and flexion and extension of the wrist are slight. The grasp of the hand is very weak. The röntgenogram is very interesting. The entire graft (*D*) can be roughly divided into three sections

(*A, B, C*). *C* is that portion of the graft which has been completely and perfectly regenerated and is thoroughly united to the old bone at *E*. *B* is that portion of the graft which has incompletely been regenerated, while *A* is that part of the graft which has been completely absorbed with no attempt at reformation of the bone in the slightest degree. The time elapsed since the operation has been over three and a half years, it is safe to say that the regeneration of bone has taken place as much as it ever will, so that we may regard this as the permanent result. Several things are evident at once—first, the result of this transplantation speaks for the value of contact with living bone, for section *C* is so perfectly regenerated because of its immediate contact with living bone at *E*. Section *B* is farther away from living bone, and as a result the new bone is only partially regenerated, being honeycombed, while section *A* is farthest away and shows absolutely no regeneration of bone after absorption of the original dead matrix, the distance away from the old live bone being evidently too great to produce new bone. It would seem reasonable to suppose that had there been live bone impinging on the carpal side of the graft the whole graft might have been regenerated. This transplantation then bears out Murphy's idea of the value of contact certainly in dead homoplastic bone graftings. That the new bone did not come from the *surrounding* connective tissue is evidenced by the progressive lessening of its formation as one proceeds towards the hand. Had this connective tissue a great influence in the formation of the new bone, then there should be as much new bone formed in section *A* as in *C*, whereas the fact is that in section *C* the new bone formation is perfect while in section *A* it entirely fails. It seems reasonable then to assume that the new bone in *C* was formed through the growing into it from the old, live stump of blood-vessels which penetrated a certain distance thoroughly and then these gradually faded out, producing less and less bone as they advanced. A better method to have employed at the time of the original transplantation than this homoplastic grafting would have been to transplant a corresponding section of the patient's own fibula with its periosteum, the upper articular fibula extremity impinging on the carpus.

To correct the present dislocation seems now to be the main indication of treatment. To do this all that would be necessary would be to resect a sufficient amount of the lower end of the ulna, which would allow of the straightening of the hand.

Homoplasty.—Homoplastic bone transplantation is the grafting of bone from *another* individual, of the same species, into the person who is to be grafted. The graft has been transplanted either living or dead.

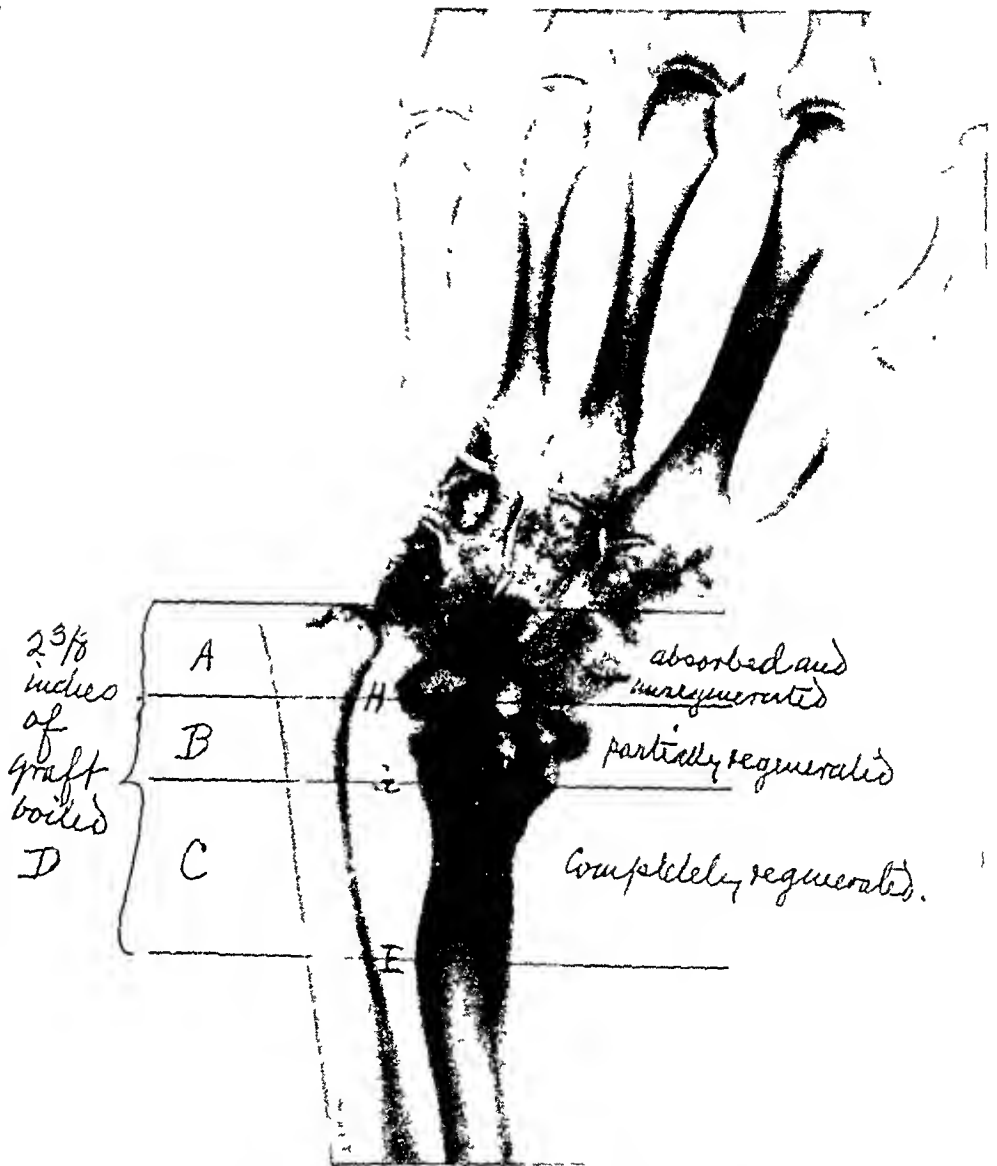


FIG. 1.—D is the 2 ³/₈ inches long, boiled, homoplastic transplant after three and one-half years. C is the completely reformed adjacent section, consolidated at E with the old, live stump. B is the but partially reformed segment, osteogenesis apparently beginning to fail. A is the segment in which the old dead bone matrix has been entirely absorbed and there is no reformation of new bone in this section, osteogenesis having entirely given out.

HOMOPLASTIC TRANSPLANTATION OF RADIUS

Dead human bone, just as animal bone and foreign material, plays the rôle of an internal prothesis rather than that of a true graft. It simply furnishes a conductor, a matrix for the periosteal regeneration of bone coming from the neighboring, living old bone. How much exciting or stimulating influence dead bone will have on this formation of new bone is questionable. The graft can certainly furnish no new bone of itself. This form of dead bone transplantation has largely been given up for good reasons. Homoplastic bone grafts are far inferior in results to autoplasmic bone grafts; but if they should be used, the grafts should be taken *living* from another individual and always *with* periosteum. In transplanting joints, it will be necessary to make a homoplastic transplantation. To obtain a living graft, it will be consequently necessary to obtain it from a fresh amputation or from a cadaver soon after death.

The success of such a living graft will depend on the serological relations between the individual from whom the graft is taken and the individual into whom the graft is to be transplanted. For in the one case the bone is originally laid down in serum of a certain composition. Bone from this individual may be transplanted into an individual whose serum may be of somewhat different composition, hence the graft will be foredoomed to more or less chemical change. The chance for success of such a graft in homoplasty will be just about in the same proportion of success as will be attained in attempting to find two bloods in blood transfusion which will agree and not hæmolyze when mixed. This is advanced as a more or less theoretical suggestion. Certainly bones from different individuals have probably different chemical compositions and the chance of grafting, from one individual into another, bone of exactly the same composition would theoretically appear to be doubtful, resulting in cytolysis. In addition, the danger of sepsis and transmitting disease as well as the inconvenience of waiting for a corpse or an amputation from an assured healthy individual have caused this method to be almost given up. Homoplastic transplants have occasionally been successful, but not as many of the osteogenetic cells remain alive and actively proliferate as in autoplasmic grafts; hence the formation of new bone is slower, and its extent is less, consequently it is more uncertain as to its ultimate success.

The following instances of both living and dead homoplastic bone transplantations I have come across in the literature. The results must in many instances be taken *cum grano salis*, since many were reported as successful which, had a greater time been given, would have proved far more successful. The results are given, however, as reported.

CLARENCE A. McWILLIAMS

(a) LIVING HOMOPLASTIC BONE TRANSPLANTATIONS

KUTTNER resected the upper third of a tibia for malignant chondroma in a man aged forty-five. The resected bone was replaced by a fragment of a tibia taken from a cadaver 27 hours after death. This graft was very well tolerated. The patient has a movable knee and can walk.

A successful case combining a heteroplastic transplantation of a kid's bone with a homoplastic graft from an asphyxiated new-born foetus is given by PONCET.

LEXER replaced the upper humerus end, including joint surface, by a piece of a freshly amputated femur. Good result.

FRANGENHEIM reports 4 cases of dowelling with homoplastic material.

V. HABERER resected two-thirds of the upper arm and filled the defect with a periosteum-covered fibula freshly obtained from an amputation. Primary union, and the arm in 5 months fully functionated.

BAUM implanted into 4 cases of pseudarthrosis, twice bones of freshly amputated extremities, and twice fetal bones. All four cases gave negative results.

ANSCHUTZ achieved a relative good result in a 7 cm. long congenital tibial defect, which had been autoplastically grafted several times with no success, by transplanting bone from a perforated foetus. A second smaller attempt with the bone of a 7 months' foetus was unsuccessful.

OLLIER replaced the totally necrosed ulna by a bony piece obtained in a fracture operation. After 5 months the transplant was absorbed.

PONCET filled the defect in a pseudarthrosis of the tibia by half the first phalanx of an amputated great toe. No consolidation. He then transplanted bony pieces taken from a child asphyxiated at birth. These were extruded.

SAMTER in an osteomyelitic total defect of the tibial diaphysis transplanted a pedunculated periosteal bony flap, which led to very small new bony formation. He then implanted a 14 cm. long cadaver bone, which after some time must again be removed. Final consolidation.

BARTH reports the implantation into a tibial defect of a piece of bone without periosteum taken from a freshly amputated leg. Resorption without consolidation. He also reports a case of ununited fracture of left leg. A graft of a piece of bone without periosteum was taken from a fresh amputation. Absorption of graft without consolidation.

GROSSE, of Halle, reported a case of pseudarthrosis of the tibia. Implantation of a fragment from a fresh amputation in an adult. Consolidation in a year between the fragments and the graft. Radiographically demonstrated. The graft appears to have undergone complete reorganization and the child can walk well. This case was reported 12 years after the transplantation by Stieda, who says that the graft now cannot be differentiated from the old bone. The child limps because of the shortness of the limb due to the destruction of the epiphyseal cartilage.

ROBERTSON resected the lower ends of radius and ulna for sarcoma. Implantation of radius and ulna with periosteum from a fresh amputated arm, the radius being wired. Amputation 12 months later because of recurrent tumor. Examination showed obliteration of the wrist-joint by fibrous tissue, also that the grafts were living. There was some motion between the fragments.

HOMOPLASTIC TRANSPLANTATION OF RADIUS

MORRISON reports removing the diaphysis of a tibia for osteomyelitis and transplanting a portion of a fibula taken from a fresh amputation. Six years later the leg had to be amputated on account of a failure to grow and of deformity. The foreign fibula was not more than a third of the size that it was when the operation was done.

KUTTNER transplanted into the defect caused by the resection of the superior extremity of the femur for sarcoma, an equal upper extremity of a femur removed from a cadaver 3 hours after death. This fragment was well tolerated. There were two local recurrences which were operated upon with success. Later, at the end of 7 months, the patient suffered a spontaneous fracture at the point of union of the dead bone with the old bone. This fracture *consolidated* and the patient had a very satisfactory function of his limb. Kuttner attaches great importance to this consolidation of the fracture and he thinks "that it shows better than any other proof could, that the bony graft had been truly alive."

STUCKEY reports a case of pseudarthrosis in the middle third of the tibia. Osteoperiosteal skin-flap with base external was taken from the upper fragment. Fragments were freshened and the marrow removed. A dowel of a portion of the entire thickness of a fibula without periosteum was taken from an amputated leg. The dowel was 11 cm. long. Its narrow canal was filled with iodoform plug and it was placed in the medullary cavities of the fragments and over this the osteoperiosteal flap was fixed with the same periosteal silk sutures. Complete consolidation in 90 days. Nine months after the operation the patient fell and fractured the graft, but this soon healed. A curved deformity resulted which had to be remedied by osteotomy. Was not this new bone formed from the old periosteum?

TERMIER resected the inferior half of the radius for sarcoma. He implanted into the defect sufficient of the fibula taken from an amputation made a few minutes before; primary union. For nine months he followed the gradual incessant destruction which by "lacunar corrosion and decalcification" produced a gradual and complete disappearance of the graft. Termier concludes that the pretended osteogenetic property of the graft does not exist, and that cytolysis and progressive absorption are almost the rule for transplanted foreign tissues.

ROVSING replaced the lower part of the femur, which he had resected for sarcoma, by a section from an old humerus, sterilized with care. The result was bad because the graft broke and there was no consolidation. He waited until he amputated a leg and took a section from the femur which he implanted into the defect 20 minutes after the amputation. A year after the grafting, there was a small fistula upon the inferior surface of the thigh. The patient has resumed his occupation as a vender and gets about on two canes, the limb being strengthened by a leather apparatus.

MACEWEN in his book mentions a living homoplastic transplantation in a boy, the whole of whose diaphysis he was compelled to remove for necrosis. There was no subsequent osseous deposition. Fifteen months later he was re-admitted with the request by the parents that the boy's useless arm be removed. Two wedges of bone were excised from another patient of six years of age afflicted with anterior curves. These were cut into minute fragments, quite irrespective of the periosteum, and were then deposited into the muscular sulcus

in the boy's arm. There was no pus formation. Two months later a portion of new bone, an inch in length and three-quarters of an inch in thickness, was found firmly attached to the upper fragment of the humerus. Here all the grafts proliferated, grew to one another, and also to the extremity of the proximal portion. Two other wedges of bone of larger size than the first were similarly dealt with and inserted two months subsequently to the first graft, and a third couple were placed in position five months after the first. These all fused together and to the condyles of the humerus, filling the gap in the arm to the extent of $4\frac{1}{4}$ inches. It is now 30 years since the humeral shaft was rebuilt, and during all this time the man has depended upon his physical exertions for the earning of his living. He worked as a joiner for many years, and is now an engineer's pattern-maker.

TROUT reports a very successful transplantation of a section of a father's tibia into a spina bifida of his child.

(b) DEAD HOMOPLASTIC TRANSPLANTS EITHER BOILED OR IN ANTISEPTICS

V. BRAMAN implanted into a humerus defect a 16 cm. long piece from the fibula which was boiled for two hours. Successful result.

FRIEDRICH resected the entire right femoral diaphysis and implanted a dead fibula from a tuberculous boy; good result. He resected also 12 cm. of the femoral diaphysis. Into this defect was implanted a boiled 17 cm. long femoral diaphysis of a sixty-five year old man who died of carcinoma. Perfect healing in of implant.

FRANKE implanted into a resected defect of the carpus, dead bone. No result. Then autoplasty from the tibia with good result.

KAUSCH in 1906 reported up to this time the greatest case of implanted dead bone which healed in the tissues. A 9 cm. long piece of the whole diameter of a tibia was obtained the day before from an amputation. It was boiled and then implanted between the resected tibial and femoral ends, these being held by ivory pegs. Primary union. After three-quarters of a year recurrence. Amputation. Autopsy showed good healing in of transplant, which was surrounded by new-formed periosteum. Case 2: Pseudarthrosis of the tibia. Implantation of a freshly-obtained phalanx from a previous operation. This was boiled. Fistula developed. Removal of implant. Case 3: Sarcoma of the upper arm. Implantation of two sterilized cadaver humeri. Removal of the same after 5 months on account of fistula formation. Case 4: Sarcoma of the upper arm. Resection. Implantation of a freshly-obtained cadaver humerus which was boiled for an hour. Removal after one month on account of infection. Case 5: Sarcoma of the internal femoral condyle. Oblique resection of this condyle. Implantation of an old anatomical lower femoral bone which was boiled. Removal of the same on account of purulent secretion on the eighteenth day. Case 6: Sarcoma of the lower femur. Implantation of a boiled anatomical department bone. Removal on account of infection.

GROSSE implanted in a pseudarthrosis of the tibia, a living exostosis from a ten-year-old girl. Primary union but absorption of the graft. The same result occurred after implanting a section from an amputated ulna without periosteum. Then complete consolidation occurred after the implantation of a boiled piece of a tibia without periosteum from an amputation. Eleven years afterwards the röntgenogram gave a single shadow of the tibia.

HOMOPLASTIC TRANSPLANTATION OF RADIUS

STIEDA implanted in a pseudarthrosis of the arm of a girl, a 16 cm. piece of a boiled fibula from an amputation. After a year there was a pseudarthrosis at the upper end of the implant. There developed fistula with final sequestration, compelling the removal of the dead implanted fibula.

KUTTNER resected, in a man thirty-one years of age, the entire upper extremity of the femur for sarcoma. He replaced the segment of resected bone by the upper extremity of a masculine femur, taken aseptically 11 hours after death from a cadaver. This segment was preserved for 24 hours in Ringer's solution with added chloroform. The dead femur was united to the remains of the healthy femur by an intramedullary ivory dowel and the tendons were united to this graft so far as possible. Death occurred 13 months later from metastases. Autopsy of the graft showed perfect insertion of the muscular tendons of the bone into the dead graft. The functional result besides was very good and the patient, 6 months after the operation, could make numerous movements of the hip. The microscopical examination of the fragment of the dead graft showed that it was "little living," and it is very probable that this dead bone was simply tolerated as an aseptic foreign body. Its utility had been considerable since new muscular insertions were made on its surface and functionally it fulfilled its rôle.

STREISSLER reports a case of comminuted compound fracture of both bones of the leg, resulting in a defect of 5 cm. in the tibia, and with overriding of the fibula fragments. After several months the granulating wound was opened, the tibial ends were freshened and the attached fibula ends separated. A 10 cm. long section from a tibia of a fresh amputation was taken and was boiled for 20 minutes in soda solution. The graft was then dowelled into the upper and the lower medullary cavities and fixed by silver sutures. The granulating surface soon became closed in. Progressive radiograms showed lacunar erosions of the graft with gradual absorption. The upper tibial fragment became consolidated with the lower fibula fragment. Final removal of remains of the dead graft. The fibula gradually increased to three times its normal dimensions, and bore the whole body weight.

In conclusion the author desires to express his indebtedness to Dr. Brewer for the privilege of reporting his interesting and instructive case.

A SYMMETRICAL CONGENITAL MALFORMATION OF THE EXTREMITIES

WITH A REPORT OF TWO CASES*

BY SAMUEL W. BOORSTEIN, M.D.

OF NEW YORK

ADJUNCT ATTENDING ORTHOPÆDIC SURGEON, MONTEFIORE HOME AND HOSPITAL; CHIEF OF ORTHOPÆDIC
DEPARTMENT, FORDHAM HOSPITAL, O.P.D.

CONGENITAL abnormalities have lately been studied with much greater interest than previously. The subject is of special interest to biologists. The patients with such congenital abnormalities are no more shown before medical meetings as mere cases of interest or for exhibition of the skill of the operating surgeon, but they are demonstrated with an interest of study. They are usually considered normal conditions of organisms in an inferior state of development. Since the work of Abbé Mendel, showing the theory of heredity, became more widespread, many of these incidents have been explained. There are still many cases which are ascribed to pressure by amniotic bands on the ossification centres, as Jansen¹ has excellently brought to light in his monograph on achondroplasia. His conclusions are: "The amnion has the power of destroying deep-lying parts in a perfectly normal embryo either with or without a simultaneous injury to the skin, and this destruction is most easily effected when the extremities are still composed of scleroblastema."

The only way in which the etiology of these cases may be cleared up is by having them reported by their observers. When the student in biology or anatomy, who is better equipped for such studies than the surgeons, tries to analyze the nature of the abnormalities, the reported cases will be at his disposal and thus he will be able to avail himself of them.

Keibel and Mall,² discussing abnormalities in the development of the skeleton, state: "The form of the skeleton as a whole and of the individual bones which compose it, depends partly upon heredity, partly upon the mechanical and chemical influences to which it is subject during growth. The variations which are a normal inheritance of the race, including such extreme forms as individuals with six fingers or six toes, are to be distinguished from the abnormalities of structures due to unfavorable environment either within or without the body.

* Cases presented before Section on Orthopædics in New York Academy of Medicine, February 19, 1915.

CONGENITAL MALFORMATION OF EXTREMITIES

The skeletal lesions vary all the way from a retardation in the time of appearance of centres of ossification to the failure of a part of the skeleton to develop."

That heredity plays so important a part in the primal origin of these deviations from normal, can be shown by comparing them to plants and lower animals. Castle³ says: "Every breeder of animals is familiar with the complexity of hereditary processes. Characters of the most varied sort are inherited. These relate not only to general size and proportion but also to the structure of the individual parts and functional peculiarities." Burbank⁴ says: "In plants you can breed in any single desirable attribute which is lacking there. Choose what improvements you wish in a flower, a fruit or a tree, and by crossing, selection, cultivation and persistence, you can fix these desirable traits irrevocably. There is a distinct similarity between the organization and development of plants and human life."

In reporting cases of abnormalities in human beings, the observer must, while taking the history and also while examining the patient, bear in mind the facts to be observed as mentioned by the authorities quoted. Thus more uniform reports for the help of the biologist may be obtained.

In trying to look up the literature on congenital abnormalities of the extremities, one finds that polydactylism was quite frequently reported, while shortening of the metacarpals and metatarsals is not so often recorded. Even Dwight⁵ in his excellent atlas (of variations of the bones of the hands and feet) does not go into great details about short metacarpals or metatarsals. He states: "There is a long type and a short type of metacarpal variation. The short is more important, as it is often at least one-half of the ordinary length. Two or three fingers may be affected in one or both hands though without perfect symmetry." He records only one case showing shortening of the fifth metacarpal and calls it a remarkable incident. He mentions nothing about metatarsal shortening. There were surely more patients with such abnormalities seen by the surgeons, but it seems that these deformities do not strike the eye as polydactylism and thus it is either unobserved or considered not of great importance. Day⁶ reports one case of symmetrical short metacarpals as unique. I have not made, however, a careful search for such reports (leaving this task to the anatomists), but am under the impression that only a small number of individuals with short metacarpals or metatarsals are on record.

Though I have nothing new to offer, I feel that I am justified in reporting in detail the two cases which came under my observation

with short metacarpals and metatarsals. These may aid the studies of the etiology.

CASE I.—M. L., female, aged thirty-five, consulted me for pain in her feet. Examination showed a plain case of double weak feet. On inspection, I discovered that the fourth toes of both feet were shorter than normal. While I was trying to find where the defect lay, the woman voluntarily offered the information that the deformity was congenital and that both hands showed exactly the same peculiarity. The hands really presented shortening of both ring fingers, the tips of these were on the same level with the tips of the little fingers, and the knuckles of the ring fingers were on a higher level than the knuckles of the other digits. There was no complaint of weakness of the hands and the muscular power was normal.

On inquiry into the hereditary history she told me that her two sisters, an uncle, an aunt, her grandmother and four other members of the family showed exactly the same defect, and that was the reason why she never worried about the unsightly appearance of her finger on which she wore her marriage ring. She said that there might be some more relatives with the same deformity, but she was not acquainted with them.*

X-rays (Figs. 1 and 2) showed clearly the shortening of the fourth metacarpals in both hands. The fourth metatarsals are also shorter than normal.

Remarks.—To discuss the origin or the cause of this particular deformity, we will quote here the statements of the authorities Keibel and Mall,² who give the following conclusions: "Agenesis or failure of skeletal development may be due either to primary lack of origin of a part or to an affection which destroys the skeleton anlage after it has begun to differentiate. It is found more often in the vertebræ, less often in the bones of the extremities. Hypoplasia or under-development of the skeleton, whether generalized or confined to a part, may be due either to prenatal or to postnatal conditions. The failure of the bones to develop normally may be due (1) to lack of active proliferation of cartilage (characteristic of cretins), (2) to inactivity of the process of ossification, (3) to a premature union of epiphysis with the main part of the bone, (4) to growth of connective tissue between the growing cartilage of a bone and the region where ossification usually

* At the time when the patient was examined, I did not consider the case of sufficient interest to make out a careful family tree. When, later on, the second patient came to me, I reminded myself of the first, and have written to her but have not been able to find her, as she left the city. I suppose that in a similar way many such cases are unreported by the observing surgeon.

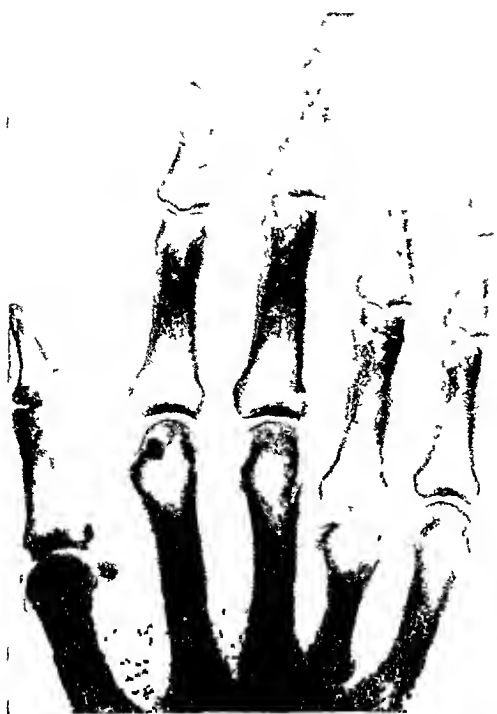


FIG 1 —Radiogram of Case I, showing the short fourth metacarpal of the right hand



FIG 2 —Case I Left hand, showing the same deformity.

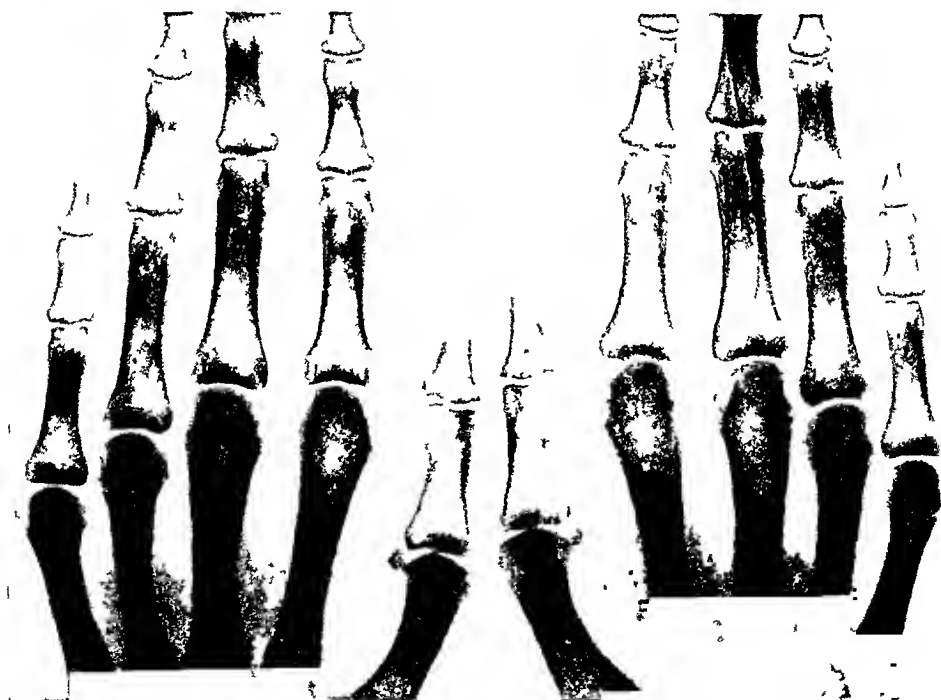


FIG 3 —Case II. Radiogram of both hands, showing the symmetrical shortening of the fifth metacarpals.

CONGENITAL MALFORMATION OF EXTREMITIES

extends into the cartilage (micromelia, chondromalacia, fetal rickets), and (5) to inflammation and other abnormal conditions affecting the growing parts of the bone." We cannot by examining such a patient tell what this particular hypoplasia is due to, but we can discuss it from a general view.

Here we will recall the early embryology of the extremities. I will refer to Bardeen⁷ and Lewis⁸ who by careful studies showed that the arm bud occurs in the fifth week, while the leg bud or anlage of the leg occurs later (about the sixth week). The cartilages which are supposed to make up the metacarpals and the metatarsals show at the sixth week, while at the seventh week the limbs begin to resemble those of an adult.

Even before obtaining the family history, we can assume that the condition in my patient is due to primary lack of origin of the anlagen rather than to an affection which destroys the skeleton anlagen after it has begun to differentiate. Since both fourth metacarpals and metatarsals have similarly been affected, we conclude that the underlying cause lies in the origin rather than in later affections. For there is no probability of having two external influences on two different structures (arm and leg buds) which, as has been mentioned before, do not originate at the same time.

Where the exact fault lies cannot, of course, be determined, but as such patients give a distinct hereditary history, we can assume with safety that there will be some more members born with such embryonic defects. Should there be some miscarriages in some of these families, the foetus could be examined by competent embryologists and probably the exact location of the origin could be found. I think that only by such studies can the etiology be cleared up.

CASE II.—A. F., female, aged nineteen, came to me complaining of cold feet which on examination was shown to be due to poor circulation with low arterial pressure. On examination of the upper extremities, the little fingers were found to be shorter than normal, the tip reaching to about the middle of the middle phalanx of the ring finger. There was nobody in her family who had a similar deformity. X-ray showed shortening of the fifth metacarpals (Fig. 3).

Remarks.—Though one would at first hand consider that the short fingers were due to amniotic pressure in view of the fact that the lower extremities had also poor circulation; still, when we note the exact symmetry of the deformity in both hands, we must put the blame on some developmental defect.

On inquiry into the family history, her mother, in trying to explain the cause of the defect, voluntarily offered the well-known explanation that it was due to some bad mental impression received by her during pregnancy (telegony). This is not the place to explain that telegony cannot cause such a deformity. According to her statement, the impression was received when she was three or four months pregnant, while, as we have mentioned before, the hands have all the characteristics of an adult at about the sixth week and thus deformity must already have existed at the time of the supposed impression. The impression to be a real factor must be within a few days of conception, and usually a woman is not aware of her pregnancy at such an early period. Harrmann⁹ has called attention that there may be some grand maternal impressions which cause deformity. It is well known to poultry raisers that it is necessary to take extra care to avoid shocks on opening and shutting the drawers of the incubators. A child can therefore be born, who bears no outward and visible sign of an inward and germinal blot received through telegony. Yet should this child in its turn become a parent, its child may be marked within and without. Within by carrying on the defective germ plasm, and without by the defective organ represented by that inward germinal defect. That defect will be carried on from generation to generation until some more dominant type overrides and ousts the characteristic defects.†

CONCLUSIONS

1. Symmetrical defects of metacarpals and metatarsals are occasionally found.
2. Bilateral congenital malformation can generally be traced to heredity, while a unilateral congenital malformation may be explained on principles of embryonic pressure defects.
3. Cases of hypoplasia and agenesis should be reported with the same accuracy as polydactylism, and thus some new light may be thrown on the subject.
4. Stillbirths, born in families having some defects in bones, should be examined by an embryologist to find whether their embryological structures are normal.

† I have lately come across a patient who had a short fourth metatarsal of the left foot. Nobody else in the family had a similar affection. Thus this deformity can probably be traced to some external influence. There are many patients who come to the orthopædist for flat-feet with one short toe and no notice is taken of the deformity. I can recall having seen many such cases. It is the symmetry that is more observed and ought to be reported accurately.

CONGENITAL MALFORMATION OF EXTREMITIES

BIBLIOGRAPHY

- ¹ Jansen, Murk: Achondroplasia, Its Nature and Its Cause. Monograph, Leiden, 1912.
- ² Keibel, F., and Mall, F. P.: Manual of Human Embryology. Lippincott, 1910.
- ³ Castle: Popular Science Monthly, July 1, 1906.
- ⁴ Burbank: Century, May, 1906.
- ⁵ Dwight, Thomas: Clinical Atlas of Variations of the Bones of the Hands and Feet. Lippincott, 1907.
- ⁶ Day, H. F.: A Symmetrical Developmental Defect Resulting in an Anatomical Anomaly. American Journal of Orthopædic Surgery, vol. xii, 1914-1915, p. 482.
- ⁷ Bardeen, Charles R., and Lewis, W. H.: Development of the Limbs, Body Wall and Back in Man. Amer. Jour. of Anatomy, vol. i, 1901-1902, p. 1.
- ⁸ Lewis, W. H.: The Development of the Arm in Man. Amer. Jour. of Anatomy, vol. i, 1901-1902, pp. 145-185.
- ⁹ Harrmann: Congenital Defects and Inheritance. West London Medical Journal, 1914, vol. xix, pp. 93-110.

PERITONEAL ADHESIONS: THEIR PREVENTION WITH CITRATE SOLUTIONS

BY M. H. WALKER, JR., M.D.

OF PITTSFIELD, MASS.

ASSISTED BY L. M. FERGUSON, M.D.

(From the Laboratory of Surgical Pathology, Harvard Medical School)

THIS report gives the results of experiments with hypertonic solutions of sodium citrate and sodium chloride, used in the hope of preventing post-operative adhesions in the abdomen. The work was suggested to the author by an article by Dr. Saxton Pope, of San Francisco, entitled, *The Use of Citrate Solutions in the Prevention of Peritoneal Adhesions* (ANNALS OF SURGERY, January, 1914).

All the experiments were performed on rabbits under ether anaesthesia, using ordinary surgical precautions against infection; number of rabbits operated upon, 63; number of operations, 104.

Formation of Adhesions.—The first step was to find a sure method of causing uniform adhesions.

It was found first that any procedure which caused injury to the peritoneum, great enough to produce the death of cells, was followed by the formation of adhesions. The greater the destruction of peritoneum, the more adhesions there were. The presence of infection with ordinary pus-producing bacteria invariably caused dense adhesions.

The densest aseptic adhesions were caused by touching the peritoneum lightly in five places with a small gauze pledget, dipped in half strength tincture of iodine. Dry gauze packed about the colon for ten minutes caused adhesions. Scratching the colon in many places over its proximal two to three inches, the scratches going through the serosa down to the submucosa, invariably caused firm adhesions. This technic of scratching the colon, being easily duplicated and sure in its results, was used in all the experiments reported below on the prevention of adhesions.

Pathology of Adhesion Formation.—Much work was done on the histology of adhesions, specimens of adhesions being taken at various stages in their development, and paraffin sections made. Good sections were secured of adhesions taken 1, 2, 4, 5, 6, 7, 8, 10, 11, 12 and 15 days after operation, and these were studied histologically for the development of adhesions.

The process is simply that of healing, as found anywhere in the



FIG. 1.—Adhesions after two days ($\times 130$ diams.). A mass of fibrin with a few cells.



FIG. 2.—Adhesions after two days ($\times 375$ diams.). Beginning organization—fibroblasts and new blood-vessels reaching out into the mass of fibrin.



FIG. 3.—Adhesions after six days ($\times 40$ diams.). Organization nearly complete

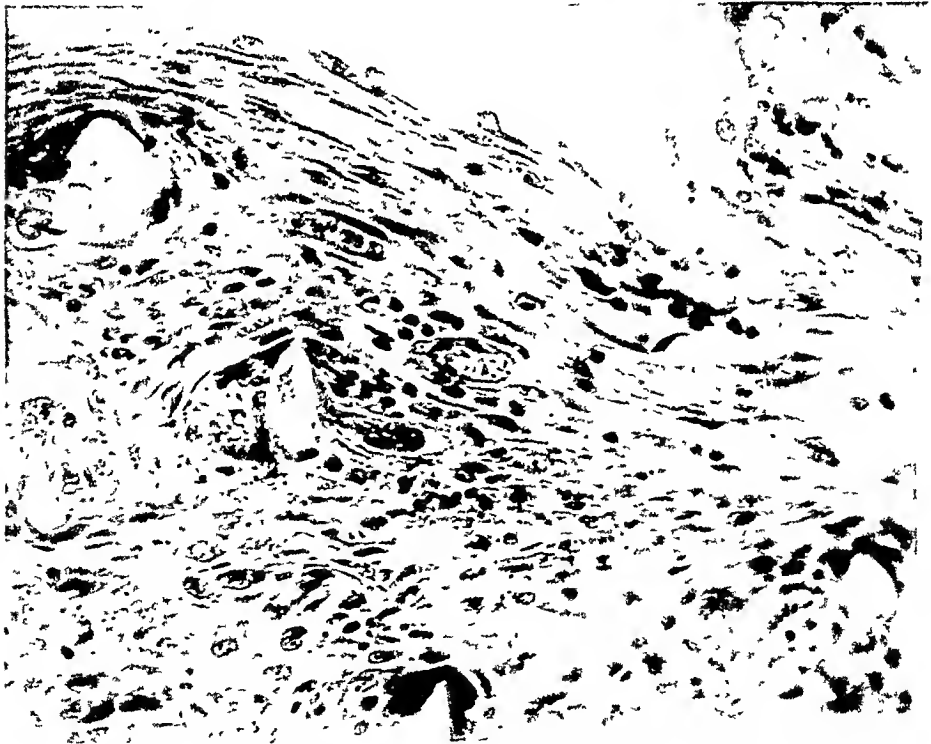


FIG. 4 —Adhesions after six days ($\times 375$ diams). Organization advanced—peritoneal cells proliferating to cover adhesions.

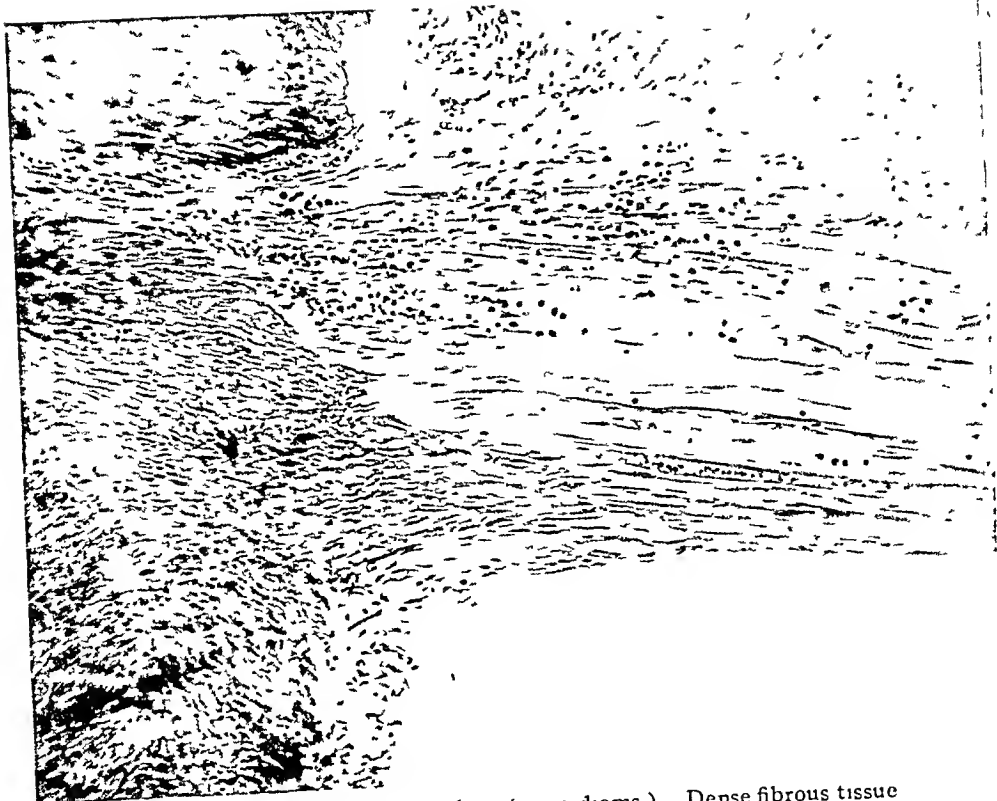


FIG. 5 —Adhesions after ten days ($\times 130$ diams) Dense fibrous tissue



FIG. 6.—Adhesions after ten days ($\times 375$ diams) Dense fibrous tissue springing from among the muscle bundles.



FIG. 7.—Scratched colon after two days ($\times 130$ diam.). Adhesions prevented by citrate solution. Wide reaction in the tissues and very little fibrin on the surface of the bowel.

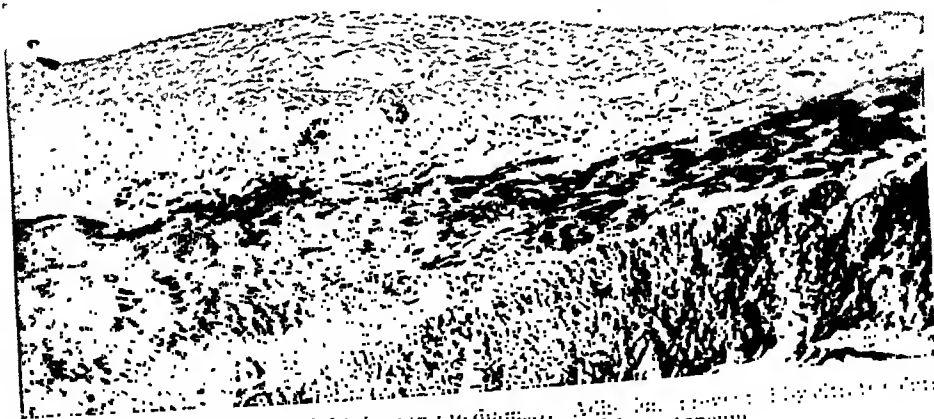


FIG. 8.—Scratched colon after eight days ($\times 130$ diam.). Adh. prevented by citrate solution. Thickened fibrous subserosa covered with peritoneum.

PREVENTION OF PERITONEAL ADHESIONS

body where tissue is destroyed, modified somewhat by the conditions in the abdomen. First, following the injury to peritoneum, an inflammatory exudate is poured out. This exudate of serum and blood very quickly coagulates and is composed of fibrin with a few red and white blood-cells in its meshes. This fibrinous mass adheres to the structures adjacent to its source, and is the framework on which the fibrous adhesion is built. Very soon (in less than 48 hours) the connective tissue and endothelial cells at the base of the adhesion begin to proliferate. Fibroblasts and new blood-vessels appear reaching out into the exudate. This process of organization goes on rapidly until, at the end of a week, the adhesion is made up of fairly dense fibrous tissue, containing a moderate number of blood-vessels, with no inflammatory exudate. As time goes on, the blood-vessels become less numerous and the tissue denser. The endothelial covering of the peritoneum at the base of the adhesion disappears, and the fibres of the adhesion appear to reach in among the muscle-bundles of the muscular coat of the bowel, or of the abdominal wall, as the case may be.

Meanwhile the endothelial cells of the peritoneum have proliferated and covered the abdominal surface of the adhesion, being continuous with the covering of the bowel. The final appearance of the adhesion is simply that of a dense scar tissue band covered with peritoneum.

Prevention of Adhesions.—The technic followed in these experiments varied somewhat in detail during the course of the work, but the principal steps were the same. Laparotomy was performed; the colon scratched as described above; and the solution to prevent adhesions introduced just before closure of the wound. The details of the technic used during the latter part of the work were as follows: The hair was removed from a small area of the abdomen with depilatory (barium sulphate and starch, equal parts). The abdomen was scrubbed with benzine, Harrington's solution and alcohol. The abdomen was opened in the median line; the proximal two to three inches of the colon scratched with a sharp-pointed knife with many scratches (40–50), the scratches going down to the submucosa. A few scratches were made in the cæcum. The peritoneum was closed with a button-hole stitch of silk, the last stitch being left loose to allow the introduction of a glass funnel. The solution being tested was poured through the funnel, care being taken to have the temperature of the solution as nearly as possible that of the body. The peritoneum was then quickly closed to prevent the escape of any solution, the skin closed with a button-hole stitch of linen, and the wound dressed with collodion.

Before undertaking the experiments with citrate solutions, one experiment was tried, to satisfy our own curiosity, using 15 c.c. of

sterilized liquid petrolatum. The abdomen was reopened in 7 days, disclosing a mass of thick, slimy adhesions. The oil had not been absorbed to any appreciable extent, and had rather increased the extent of the adhesions. This observation is borne out by the results of other experimenters.¹

Theory for the Use of Citrate Solutions to Prevent Adhesions.—

The first step in the formation of adhesions, as we have seen, is the production of a mass of fibrin, the foundation for the fibrous tissue. If then we can arrest the process at the first step, *i.e.*, prevent the coagulation of the exudate with the resulting fibrinous mass, we can prevent adhesions.

Fibrin is formed by the action of thrombin on fibrinogen which ordinarily takes place in shed blood. There are two factors necessary for this action to take place:²

1. Calcium—in the absence of calcium, shed blood remains fluid.

2. Some undetermined substance in the nature of a kinase which activates the inactive prothrombin of the circulating blood to form the active thrombin.

It is well known that fibrin formation in shed blood can be delayed indefinitely by the addition of citrates or oxalates to hold the calcium. Why should not this principle be applied to the fibrin formation of early adhesions?

This, then, is the theory on which the work is based.

The next problem is that of keeping the solution in the abdomen long enough to take up the calcium in all the exudate which will be poured out after injury to the peritoneum. Isotonic or hypotonic solutions are absorbed very rapidly by the peritoneum, large amounts being taken up in a few hours.³ On the other hand, hypertonic solutions remain much longer; the amount may even be greater after a few hours than that originally introduced, because of the outpouring of fluid from the tissues to equalize osmotic pressure. In our experiments with hypertonic solutions in the abdomen we have found some of the fluid present after 48 hours.⁴ At this time the acute exudative reaction following peritoneal trauma seems to be well over. The solutions chosen

¹ Adams, Joseph E.: Peritoneal Adhesions—An Experimental Study. *The Lancet*, March 8, 1913.

² Howell, W. H.: *Rôle of Antithrombin and Thromboplastin in Coagulation of the Blood*. *Am. Jour. of Physiol.*, vol. xxix, p. 187.

³ Robinson, Byron: Observations upon the Absorption of Fluids by the Peritoneum. *ANNALS OF SURGERY*, vol. xxv, p. 332.

⁴ Pope, Saxton: Use of Citrate Solutions in the Prevention of Peritoneal Adhesions. *ANNALS OF SURGERY*, vol. lix, p. 101.

PREVENTION OF PERITONEAL ADHESIONS

for our experiments, therefore, were hypertonic solutions of sodium citrate and sodium chloride.

First, to make sure of the harmlessness of the solution, 5 c.c. of a solution of sodium citrate 2 per cent. and sodium chloride 3 per cent. was injected into the jugular vein of a rabbit. No ill effects whatever followed.

The experiments with the various solutions of citrate and chloride with their results are recorded in the following tables. Adhesions are not considered true, lasting adhesions until at least four days after operation, for earlier than that they are mostly fibrinous and many of them may be broken up by peristalsis, movements of the animal, etc., and may not appear later. A few abdomens were reopened earlier than four days in order to secure early specimens for histological examination, but these are not included in the tables. For convenience we have adopted the following method of designating the extent of adhesions:

+++ signifies the amount of adhesions resulting from scratching the colon when no preventive measures are taken.

++ signifies a definitely less extensive group of adhesions.

+ signifies a very slight adhesion between the bowel and the abdominal wound, without any between bowel and bowel. Such adhesions practically always were found where the wound was septic.

EXPERIMENTS AND TABULATED RESULTS

Group 1.—Using sodium citrate 2 per cent. and sodium chloride 3 per cent., about 12 c.c. Six operations; results as follows:

| | | |
|-----------|--------------|------------|
| Adhesions | 0 in 2 cases | |
| Adhesions | + | in 2 cases |
| Adhesions | ++ | in 1 case |
| Adhesions | +++ | in 1 case |

Complete success in $33\frac{1}{3}$ per cent.

Partial success in $83\frac{1}{3}$ per cent.

Group 2.—Using sodium citrate 2 per cent. and sodium chloride 8 per cent., about 12 c.c. Seven operations; results:

| | | |
|-----------|--------------|------------|
| Adhesions | 0 in 2 cases | |
| Adhesions | + | in 2 cases |
| Adhesions | ++ | in 2 cases |
| Adhesions | +++ | in 1 case |

Complete success in $28\frac{1}{2}$ per cent.

Partial success in $85\frac{1}{2}$ per cent.

WALKER AND FERGUSON

Group 3.—Using sodium citrate 1 per cent. and sodium chloride 2 per cent., about 12 c.c. Four operations; results:

Adhesions 0 in 1 case
 Adhesions + in 1 case
 Adhesions ++ in 1 case
 Adhesions +++ in 1 case
 Complete success in 25 per cent.
 Partial success in 75 per cent.

Group 4.—Using sodium citrate 2 per cent. and sodium chloride 1 per cent., about 12 c.c. Four operations; results:

Adhesions 0 in 0 cases
 Adhesions + in 2 cases
 Adhesions ++ in 2 cases
 Complete success in 0 per cent.
 Partial success in 100 per cent.

Group 5.—Using sodium citrate 2 per cent. and sodium chloride 2 per cent., about 12 c.c. Two operations; results:

Adhesions 0 in 0 cases
 Adhesions ++ in 1 case
 Adhesions +++ in 1 case
 Complete success in 0 per cent.
 Partial success in 50 per cent.

Group 6.—Using sodium citrate 3 per cent. and sodium chloride 1 per cent., 20-25 c.c. Seventeen operations; results:

Adhesions 0 in 12 cases
 Adhesions + in 3 cases
 Adhesions +++ in 2 cases
 Complete success in 70½ per cent.
 Partial success in 88⅓ per cent.

Theoretically, the effect of oxalates should be the same as that of the citrates. Therefore, two experiments were performed using a solution of potassium oxalate 3 per cent. and sodium chloride 1 per cent. The first animal died about ten minutes after the operation from shock; and the second died during the second night presumably from the same cause.

The best solution, then, was found to be that used in Group 6, citrate 3 per cent. and chloride 1 per cent. Of the five cases which developed adhesions when treated with this solution, 4 had septic wounds, and we found that the presence of sepsis always caused adhesions. The other animal died of pneumonia in 3 days and had peculiar hemorrhagic septic adhesions.

It is fair to say, then, that in the absence of sepsis, and under good conditions, this solution always prevented the formation of adhesions.

PREVENTION OF PERITONEAL ADHESIONS

The amount of surgical shock caused by the solutions varied with their tonicity. This shock was measured in these rabbits by their rousing from ether when the solution was introduced, and by their recovery from ether. The solutions of very high tonicity, like the oxalate, caused most shock and even death in a few cases. It is well known that rabbits are more susceptible to any surgical procedure than almost any other animal. Hence things which cause profound surgical shock in rabbits may have no effect on cats or other animals. Our best solution, in some cases, caused slight rousing from ether, but the animals recovered quickly, in 10–15 minutes, and in no case were there any lasting effects.

Attempts to Prevent Adhesions from Reforming.—It is much easier to prevent adhesions than to cure them. The reason for this is probably largely found in the histology of adhesions. As we have said, the normal peritoneal coat of the bowel at the base of an adhesion is destroyed. Hence when the adhesion is removed a large area is left denuded of its peritoneum. Also in our work many abdominal wounds went septic after the second operation.

We performed 18 experiments of breaking up post-operative adhesions and introducing hypertonic citrate solutions of various strengths. Only one case was a complete success. Twenty-two per cent. of the cases were benefited by the treatment, but still had a few adhesions. The results here should be much better in human surgery, for there the element of sepsis would be practically wiped out.

The healing of the scratches in the colon where adhesions have been prevented, is much like the healing of a skin wound which is kept covered with a wet dressing. The reaction in the tissues extends far beyond the line of the scratch. The subserosa and the muscular layers of the colon are filled with an exudate of serum, fibrin, and blood-cells far beyond the scratch. There is very little fibrin on the surface of the bowel, though the scratch itself is filled with an exudate. This exudate, however, contains a much smaller proportion of fibrin and a larger proportion of cells than the usual inflammatory exudate. The healing goes on in the usual way with the organization of the exudate, fibrous tissue formation, proliferation of the peritoneal endothelium to cover the defect; and the result is a somewhat thickened fibrous subserosa.

The effect of the citrate solution on the healing of scratches in the colon, therefore, is a very definite, marked diminution in the amount of fibrinous exudate, produced as an immediate result of the trauma. The prevention of adhesions is due to this fact, there being too little fibrinous exudate allowed to coagulate on the surface of the colon to cause adjacent surfaces to stick together.

CONCLUSIONS

1. Hypertonic citrate solutions do, under certain conditions, prevent peritoneal adhesions after laparotomy. The best solution is sodium citrate 3 per cent. and sodium chloride 1 per cent.

2. In human surgery, the citrate solution should, theoretically, be used as it has been experimentally: *i.e.*, after clean laparotomies, a sufficient amount of solution should be introduced into the abdomen to bathe the whole peritoneum (500-600 c.c.). Smaller amounts would be of little value, for any fluid introduced into the abdomen soon becomes distributed over the whole cavity. Practically, the question of whether or not the citrate solution will cause surgical shock in humans, must be determined by actual tests in the operating room. If, as we anticipate, no shock is caused, the solution should be used as advised above.

3. When it is necessary to pack off intestines with gauze, if the pack is wet with citrate solution, much fewer adhesions should result.

4. Absolute asepsis is essential. Adhesions cannot be prevented in the presence of infection.

5. Gentleness in handling peritoneum is important, for the more injured peritoneum left after operation, the greater is the likelihood of adhesion formation.

6. Large areas denuded of peritoneum should be covered by plastic operations or omental grafts, for the larger the denuded areas left, the more difficult is the prevention of adhesions.

7. Iodine should be used in abdominal surgery with great care, or better, not used at all, for a very little of it allowed to touch the bowel causes masses of adhesions.

8. Dry gauze should not be allowed inside the abdomen.

BIBLIOGRAPHY

- Pope: ANNALS OF SURGERY, vol. lix, p. 101.
 Richardson: ANNALS OF SURGERY, vol. liv, p. 758.
 Adams: The Lancet, March 8, 1913.
 Robinson: ANNALS OF SURGERY, vol. xxv, p. 332.
 Pribram: Arch. f. klin. Chir., August, 1914.
 Morris: ANNALS OF SURGERY, vol. lv, p. 804.
 Steffins: Beitrag z. klin. Chir., 1899, xxiii, 302.
 Wegner: Arch. f. klin. Chir., 1877, xx, 51.
 Graser: Deutsch. Zeitsch. f. Chir., 1887-1888, xxvii, 533.
 Hertzler: Tr. Western Surg. and Gyn. Assoc., December, 1904.
 Walthard: Cor. Bl. f. Schweiz. Aertz., 1893, xxiii, 513.
 Howell: Am. Jour. of Physiol., xxix, 187.
 Prime: Surg., Gyn. and Obstet., xvii, 617-625.
 Cramer: Quarto. Jour. Exper. Physiol., 1913, i, 11.
 MacRae: Am. Jour. of Physiol., xxxii, 211-218.
 Ostrom: Jour. Am. Inst. Homeop., iii, 783-792.

THE PREVENTION OF PERITONEAL ADHESIONS BY THE USE OF CITRATE SOLUTION*

BY SAXTON POPE, M.D.

OF SAN FRANCISCO, CAL.

INSTRUCTOR IN SURGERY IN THE UNIVERSITY OF CALIFORNIA MEDICAL SCHOOL

IN the past two years at the University Hospital, and in the private work of Dr. Wallace I. Terry, we have used a solution of citrate of soda 2 per cent. with sodium chloride 2 per cent. in some 400 abdominal sections. All sponges and gauze pads were moistened with this solution.

In about twenty cases, a considerable quantity of the solution was left in the abdominal cavity. This amount ranged from 4 ounces to a pint. Since this procedure causes pain and partially rouses the patient it has been found expedient to have the incision almost closed before introducing the liquid. The abdominal wounds do show more oozing during closure, but in no case has it seemed to lead to failure of union nor to post-operative bleeding.

There is no evidence to show that the liability to infection is increased, but, on the contrary, where peritonitis was present, a marked improvement seems to have occurred.

The character of cases in which a quantity of solution was left in the abdominal cavity included general post-operative adhesions, acute obstructions, pus tubes, colectomies, resections, and tuberculous peritonitis. Ten of the entire number of cases have come to reoperation and the state of the peritoneum could be inspected.

While it is very difficult to judge the evidence thus afforded, impartially, it is universally conceded by the surgical staff that there was a marked improvement in all but two instances. In such operations as appendectomies, where, upon reopening the abdomen, the omentum usually is found adherent to the old cicatrix, after citrate employment no such adhesions exist.

The two cases showing little or no benefit from the solution were those of a perforating duodenal ulcer following gastro-enterostomy and chronic plastic peritonitis with multiple intestinal ulcers.

The most striking improvement was evident in a case of long standing stasis with adhesions and one of tuberculous peritonitis. In no instance did we use this measure as a substitute for peritoneal grafts or

* Read before the County Medical Society, January, 1915.

plications. It is not intended to take the place of plastic repair of the peritoneum.

It is conceded that judgment is difficult and experience fallacious, here as in other medical problems. But in the use of citrate solution we have a new hypothesis and convincing experimental evidence.

In the place of a mechanical conception of protection within the abdomen, and the use of such foreign substances as petrolatum and other tissue insults, we conceive inflammatory deposits to depend upon similar factors to those active in the production of thrombosis. We seek to limit fibrin deposits in the peritoneal cavity by an inhibition of the fibrin ferment.

It is not possible to abolish inflammatory repair nor do we attempt this. Our effort is to prevent excessive fibrin deposit and the subsequent conversion of this into adhesions.

By a comparative test of some twenty-four different substances, all of which have in the past been recommended as preventives of adhesions, we have shown by repeated experiments¹ on rabbits that citrate solutions are definitely superior to all hitherto suggested measures.

Petrolatum, camphorated oil, olive oil, butter, sugar solutions, ether, salt solutions, vitreous humor, paraffin oil, various membranes and powders all have been used. Some were found absolutely destructive and harmful—all are incompatible with animal tissue, and none compared in its preventive action with solutions of salt and sodium citrate.

Clinically, the evidence is more difficult to interpret, but the results in these 400 cases warrant us in recommending its use. It is not only a reasonable theory, one proved experimentally, but it is a safe surgical procedure.

Results of 100 Experiments on Rabbits.—After scarifying the colon and scrubbing the peritoneum with gauze—half an ounce of one of the following substances was poured in the abdominal cavity—the results after one week, are recorded as follows.

TABLE I

| | Exudate | Adhesions |
|-----------------------------------|---------|-----------|
| Control | + | ++ |
| Tr. iodine | ++ | ++ |
| Camphorated oil | +++ | +++ |
| Olive oil | ++ | ++ |
| Petrolatum | ++ | ++ |
| Butter | ++ | ++ |
| Sugar 50 per cent. solution | + | ++ |

¹ The Use of Citrate Solutions in the Prevention of Peritoneal Adhesions.
ANNALS OF SURGERY, January, 1914.

PREVENTION OF PERITONEAL ADHESIONS

| | Exudate | Adhesions |
|--|---------|-----------|
| Citrated sugar | + | + |
| Egg albumen | + | + |
| Citrated egg albumen | ++ | + |
| Milk | + | + |
| Peptonized milk | + | — |
| Ringer's solution | — | ++ |
| Salt solution, normal | — | + |
| Ether | +++ | ++ |
| Vitreous humor | — | + |
| Paraffin oil | + | + |
| Oleum Telesphoros | ++ | + |
| Bloodclot | ++ | + |
| Ammonium oxalate 1 per cent. } | — | + |
| Salt solution } | — | — |
| Citrate of soda 1 per cent. } | — | — |
| Salt solution } | — | — |
| Sodium citrate 2 per cent. } in water | — | — — |
| Sodium chloride 4 per cent. } | — | — — |
| Citrate of soda solution 2 per cent. } | — | — — |
| Salt solution 3 per cent. } | — | — — |

REMARKS ON THE SURGERY OF THE EUROPEAN WAR*

WITH A DESCRIPTION OF AN IRRIGATION SYSTEM FOR PERFORATING INFECTED WOUNDS

By EDMUND B. PIPER, M.D.

OF PHILADELPHIA

ASSISTANT SURGEON, OUT-PATIENT DEPARTMENT OF THE UNIVERSITY OF PENNSYLVANIA HOSPITAL; FORMERLY
ASSISTANT SURGEON, AMERICAN AMBULANCE, PARIS, FRANCE

ON the first of July, 1915, the University of Pennsylvania Unit, headed by Dr. J. William White and Dr. James P. Hutchinson, took over the University Unit of the American Ambulance in Paris from the representatives of the Harvard University.

The American Ambulance was started by the Americans in Paris, especially those connected with the American Hospital, which is situated in Neuilly just outside of the gates of Paris. This little hospital has about fifty beds and is very efficient in every respect. I believe the original idea was to construct a small temporary war hospital within its grounds. However, soon after the war began the French government turned over to the American Hospital the nearly completed school building, known as the Lycée Pasteur in Neuilly, to be used as a War Hospital, and this was where our work was done. At the time the war broke out, in August, 1914, this building was very nearly ready for occupancy. It is a structure which in America would cost from half a million to a million dollars and is built of brick with stone trimmings. There are four floors and a basement. The entire building is open to light, it being constructed in corridors with a front administration building and a central garden or court, so that all parts open within and without. The basement was used for dining halls and storage rooms. The first or ground floor has three large and seven small wards and the second and third floors each have about eighteen or twenty small wards of ten beds each. The dental department is on a wing of the second floor, the main operating room on a wing of the first floor, and the University Unit operating room on a wing of the fourth floor. The ambulance drivers and orderlies sleep on the fourth floor. The building, except for the fact that there are no elevators, is remarkably well adapted for the use of a hospital. The wards are very light, and there is plenty of air. The absence of an elevator, however, is a very great disadvantage, since one operating room is on the first floor and the other on the fourth, also that there are two X-ray plants, one adjacent to each operating room.

* Read before the Philadelphia Academy of Surgery, November 1, 1915.

THE SURGERY OF THE EUROPEAN WAR

When I went on duty the services were divided as follows: Dr. DuBouchet was Surgeon-in-Chief and had a service of his own of approximately 160 beds; Dr. Blake had a service of 150 beds; Dr. Mignot of the French Army had a service of about 80 beds; and the University Unit had a service of 180 beds, which included the entire third floor with the exception of one ward. This was given over to the treatment of the eye, and was in charge of Dr. Hunter Scarlet.

The orderlies were of all types; some were paid, most were volunteers. Some of the finest types of men I ever met were doing that very necessary work. There were at least a dozen Oxford undergraduates working in that capacity, most of these being American Rhodes scholars, and as a rule these men did their work well. I, personally, never failed to have an orderly do whatever I asked him to, cheerfully and willingly at any time of the day or night. There were a great number of different nationalities represented among the workers, including doctors, orderlies, nurses and auxiliaries. My recollection is that they include French, American, English, Scotch, Irish, Canadians, Australians, Swiss, Russians, Belgians and Danish.

The question of infection is naturally a very important one, and I feel safe in saying that all the cases, or practically all, were infected at least in a slight degree. The slightly infected wounds were usually in those parts not covered by clothing and in which there was a slight laceration by a piece of shell or a clean puncture by a high velocity bullet. The infections were of all the usual types that we find at home with the addition of the gas bacillus. It seemed to us that the severity of the infection in many instances was increased when the patients gave a history of a great number of different dressings done in different places in the first forty-eight hours following injury. The length of time that the man had worn his clothing, both uniform and underwear, was another important factor in determining the severity of the infection. In many cases, injured in a part covered by clothing, pieces of coat, underwear, socks, etc., were recovered from the wounds for a long period of time following admission to the hospital.

In discussing the treatment of these varied types of wounds, I might say that hardly any two cases could be treated alike. Of course, the same general principles applied to all and sometimes the success or failure of a type of apparatus for one case would be of value in treating succeeding similar cases.

In deciding how we should treat a given case, it was necessary first to determine whether amputation would or would not save life. (Of course, all wounds were not of the extremities, but I am speaking of

them in that manner because a large proportion were, and because it was mostly in these cases where the question of judgment was of vital importance.) Our attitude was to avoid amputation when possible, not from the idea of the end-result to that particular part, but from the point of view as to whether the patient would throw off the infection and stand later amputation better.

After placing the injured part in that type of apparatus which appeared to be most comfortable, the question of the treatment by dressings came up. These were usually one of three classes: First, wet gauze dressings frequently changed; second, the steady drip of some solution; and third, irrigation.

The solutions most frequently used for wet gauze dressings were the sodium hypochlorite solution of Dr. Carrel, a normal salt solution, boric acid solution, alcohol, and sterile water. Except for the alcohol, these were always used very hot, very well wrung out, and very well covered. Our Service felt that the type of solution used in this manner was a very small determining factor as to the result. For irrigations the solutions used were again the hypochloride, salt, sterile water, and, in addition to these, sometimes weak iodine. Again, in this type of treatment we felt that the determining factor was not the chemical constituency of the solution so much as the mechanical action. Dripping of wounds was done mostly in those widely lacerated superficial wounds where there was very violent infection.

Continuous irrigation was used in some cases of through-and-through perforating wounds, also in some few punctured wounds, but these latter were done more frequently at the time of dressing once or twice a day. There were numerous types of permanent irrigations. Dr. Alexis Carrel recommended one that was apparently the most efficient. The description that was given me of this apparatus was that a tube was placed in a wound of entrance and sealed there with collodion, and a tube placed in a similar manner in the wound of exit. The solution was therefore forced into the wound and out of the wound and the external surface of the limb was kept dry. The disadvantage of this was that it was not applicable in those cases in which the wound of exit was accompanied with terrible lacerations of the skin and soft parts. There was another type of irrigation in which a fenestrated tube was carried through and through the wound which connected above with the irrigating can and below with a waste bucket. Again the disadvantage of this was that the irrigation ended by being mostly of the tube itself and not of the wound. There were many other types. My colleague, Dr. Keating, evolved a very ingenious scheme

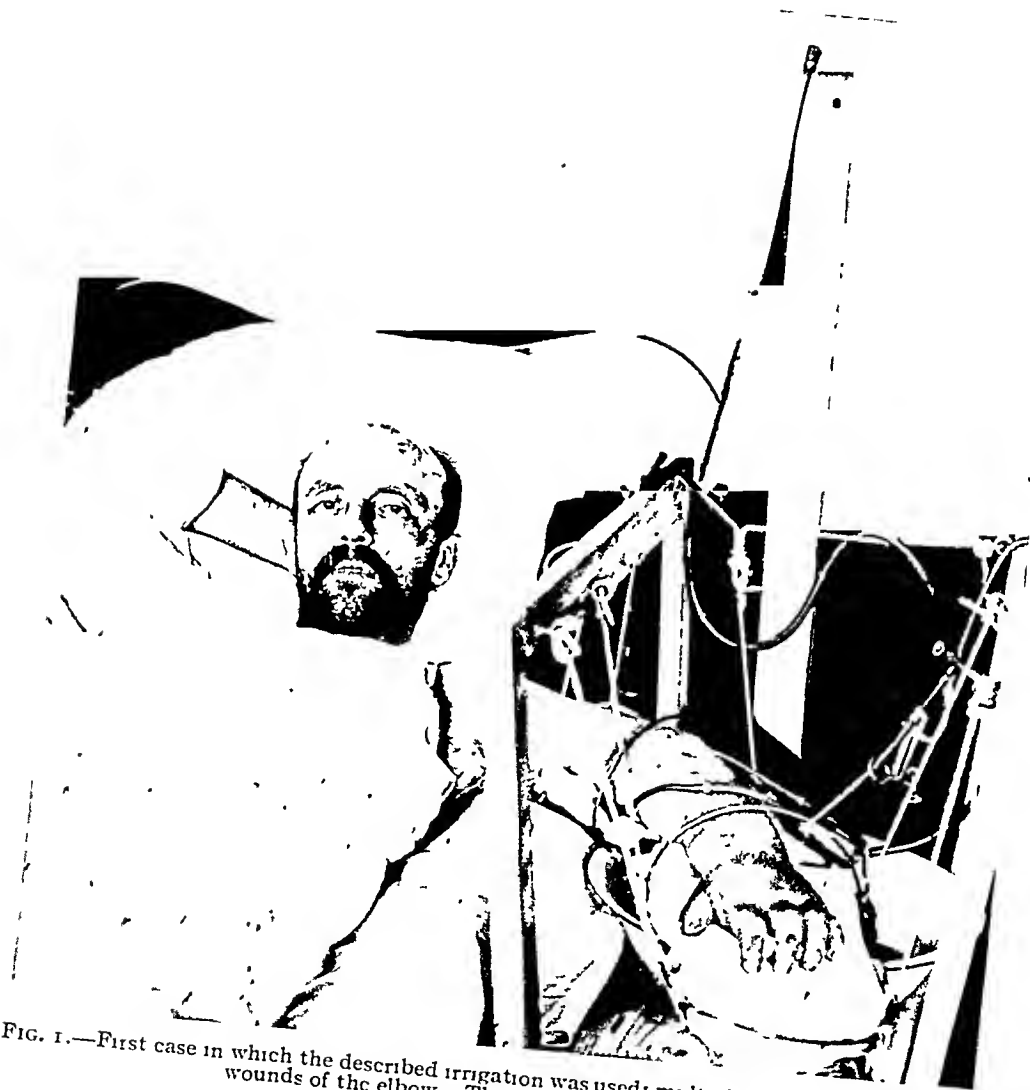


FIG. 1.—First case in which the described irrigation was used; multiple through-and-through wounds of the elbow. The result was satisfactory.

THE SURGERY OF THE EUROPEAN WAR

with which he could irrigate from one main irrigating can multiple wounds of the arm or leg.

There were some cases of through and through wounds in which apparently hot wet dressings did not clear up the infection and some type of continuous irrigation was essential. After seeing some of these irrigations it occurred to me that if an old fundamental principle of hydraulics were used, we could procure an actual forced irrigation of the wound under pressure. This principle which I made use of was that water always flows the easiest way and that the easiest way could not possibly be through a wound unless it was forced through by back pressure, and therefore I worked out the following simple apparatus.

A soft rubber tube of the size necessary for a given wound was used. In the centre of this tube there was a single window cut in the shape of a gutter. This was placed in the wound, usually with the patient under anæsthesia. An irrigating can with a shut-off valve was connected with a glass T-tube. Soft rubber tubes came off of either end of the T, both of these having a shut-off valve either within them or a metal clamp. These were again connected with the tube within the wound at either end, and at the most dependent portion another T-tube was placed to which was attached another rubber tube with a shut-off valve which emptied into a bucket. In this way the water could be carried from the irrigating jar to the T-tube (Fig. 1), and by opening the valve on one side and closing it on the other the flow of the water was directed through the tube in the wound in whichever direction desired. With the valve on the dependent T-tube opened, the water flowed through the tube in the wound directly into the waste bucket, which showed us that the wound itself would not be irrigated in that manner, but when that lowest valve was closed, giving a back pressure, there was only one possible place that the water could escape, namely, through the window in the tube within the wound. In this manner the wound itself was irrigated around the tube and the pus was washed out mechanically. A slight change in the position of the window would determine which end of the wound would be flushed. In this manner we were able to keep up free drainage continuously. The solution coming from the wound was directed into the waste bucket, by rubber sheeting, and thus the bed was protected. This was tried on a number of cases with reasonably satisfactory results. *No irrigation of any type seemed to be of any value unless there was proper and sufficient drainage.*

There has been diversity of opinion in regard to the treatment of the gas bacillus infection. I believe it is generally agreed that where

gangrene resulting from this infection has set in, immediate amputation is indicated. There are some men who think that amputation is indicated whenever the diagnosis "gas infection" has been made, even when there is no evidence of gangrene. The feeling of our service was that cures of gas bacillus infection could be brought about without amputation if proper and sufficient drainage were instituted. By this I mean drainage not only of the skin and superficial fascia, but wide-open drainage of the muscles around the seat of infection. It was our policy to open the infected areas freely in many places and to insert through-and-through drainage tubes.

The following case that I will try to give from memory is typical of gas bacillus cases that are admitted to the American Ambulance.

This man was admitted a few days after he was wounded. He had had both legs amputated below the knee at the Base Hospital. The left leg was a straight amputation without flaps, and not closed. The right leg had been amputated with apparently some post-operative hemorrhage which had been controlled by packing, and a few sutures had brought the flaps together. When this man was dressed and the packing was removed there was no difficulty in making the diagnosis of "gas infection," as the gas bubbled out in abundance. The man was immediately taken to the operating room where all the sutures were removed and the stump was laid wide open. The question of further amputation above the knee was brought up and, with the exception of our chief, Dr. Hutchinson, practically every man present was in favor of further amputation. Dr. Hutchinson decided, however, that he would give the stump very free drainage and wait. The patient was returned to the ward, where the stump was put in a sling, was extended outside of the bed and a continuous drip of a salt solution was commenced. Twice daily the stump was irrigated with peroxide of hydrogen, which was washed off with a weak solution of iodine. At the time this treatment was instituted there was practically not a particle of live tissue visible. The bone was protruding for possibly two inches, all the muscles were gray and absolutely necrotic. I had this man in my ward for two months. When I left, the left stump was entirely healed and the right stump, which at the beginning of the treatment had been at least eight inches in diameter, was healed with the exception of about three-quarters of an inch, and there was a very little bit of bone still showing, but not protruding.

Practically all amputations that came to us from the front were no-flap amputations, and these were all treated in the same manner, namely, an extension put upon the flaps.

THE SURGERY OF THE EUROPEAN WAR

The wounded that came to the American Ambulance during our period of service and for some time preceding that were all French or at least of the French Army. There were some Moroccans and Algerians, and some of the French negroes. The attitude of these men was nearly without exception that which made it a pleasure for anyone to work with them. They were always game, courteous, happy when not in actual pain, and full of gratitude for what little we were able to do for them. One case will always stand out in my mind as typical of the French people in this time when their very life is at stake. This case was a violent infection with fracture at about the middle third of the femur. He was turned over to us by the Harvard Unit, and I was warned by Dr. Collier of that Unit that he was in a serious condition. He was in a plaster cast with the usual reinforced window over his point of infection. About four days after we went on duty, in the night he had a hemorrhage. When I arrived in the Ward he was bleeding rather freely, and, of course, owing to the cast we were unable to use a tourniquet and I did not feel that there was time to remove the cast. With the aid of two candles (no electric lights were allowed after nine o'clock at night on account of the danger of Zeppelin raids) I packed this man's wound of entrance and exit under ethyl chloride general anæsthesia. When the hemorrhage was controlled his first words when he came out of anæsthesia were, "*Merci, Monsieur le Docteur.*" Gentlemen, that typifies the French soldier and his innate courtesy, which supersedes everything else. Another example—during the month of August I was slightly ill for a couple of days, which I spent in the American Hospital. The first day I arrived there I received a large basket of flowers, with a letter written in French by one of my fifty wounded men, and signed by every other one. I hardly believe that any set of ward patients in a home hospital would show that kind of consideration.

There was one man who suffered tortures every time I had to dress him for several weeks. I have seen him stuff a red bandana handkerchief in his mouth so that his groans would not disturb me. I have told him after a dressing that I was very sorry to have to hurt him, and his reply was always the same, "What would you? It is necessary." This same man when he was evacuated later to a less active hospital frequently came back to see us. The last time I saw him he told me that the surgeons in his new hospital wanted to open his arm and drain it. I asked him what he did and he replied that he would not let them do it. Then I said, "But supposing we wanted to do it?" His immediate reply was that that would be all right, and that was the attitude of the French soldier to the American doctors.

In closing there is one point that struck me most forcibly, namely, *War Surgery is distinctly Ward Surgery*, and the results that are attained are much more dependent upon the treatment in the wards, than upon the operations that may be done. Of course, many operations are needed, but that is the smallest factor in determining the end-results. Any man going to serve in a War Hospital with an idea that he will procure a large operative experience I believe will be sadly disappointed, but it seemed to us that the treatment of the cases in the wards was far more interesting and valuable than any operative experience that might be acquired, and no member of our Unit will ever regret the trip.

FRACTURES OF THE NECK OF THE SCAPULA*

BY JAMES MORLEY HITZROT, M.D.

AND

R. W. BOLLING, M.D.

OF NEW YORK CITY

FRACTURES of the neck of the scapula with or without involvement of the glenoid fossa, while not common, have been found to be of more frequent occurrence since the advent of the X-ray.

Nearly all the clinical features of fractures of this region are based upon the description by Sir Astley Cooper of three personal cases, two of which at autopsy proved to be fractures of the surgical neck of the humerus. In brief, the symptoms ordinarily given are, flattening of the shoulder, the prominence of the acromion, the easy reduction of the downward displacement by raising the elbow and the immediate return of that displacement when this support is removed, and the occurrence of crepitus during the above manipulations.

With the appearance of the first two of the above symptoms we can heartily concur, although fracture of the surgical neck of the scapula may occur without any distinguishable deformity (see Case I).

In all of our cases in which there was not some concurrent injury to other structures, such as deltoid paralysis (Case VI) and the complicated lines of fracture in Case VII, there was no displacement which could in any way be affected by raising the arm, or by traction upon it. In our cases, likewise, passive movements of the arm described by Grüne as practically free and painless were distinctly restricted to very slight movements, and all were accompanied by pain referred to the infraclavicular fossa.

We must also disagree with Grüne in his statement that fracture of the neck of the scapula is one of the most common forms of scapular fractures and agree with the other writers that this is one of the less common types of fractures of the scapula.

The facts contained in this paper are based upon eight cases of fracture involving the neck of the scapula, and a series of experiments on the cadaver done chiefly to clarify our knowledge of the clinical types as we saw them.

* Read before the New York Surgical Society, December 8, 1915.

The case reports follow:

CASE I.—Thomas M., aged forty-four, was admitted to the First Surgical (Cornell) Division of the New York Hospital on December 12, 1914, with a history of having fallen against a trap-door four days previously. The injury was evidently merely annoying, as the patient did not seek treatment until the following day, and then because of the inability to use his left arm. He was treated for a sprained shoulder.

On his admittance to the hospital he had complete disability of the left shoulder. There was the very slightest difference in the two deltoid regions, perhaps only perceptible because of the prominence of the acromion process on the left side which made the contour seem slightly less rounded on that side. The left coracoid process was not so distinct as the right, and pressure over it caused pain in the infraclavicular fossa. There was pain in this region also upon pressure inward against the head of the humerus. Passive motions were less restricted than in the other cases in our series, but were distinctly limited, and the pain which occurred was referred to the infraclavicular fossa and to the summit of the axilla.

There was no ecchymosis, no change in the relationship of the head of the humerus and the acromion, and there was no change in the measurements from acromion to external epicondyle.

An attempt was made in this instance to measure the change in position of the two coracoids, measuring from the median line, and a difference of 0.25 cm. was found, that on the left side being that much nearer the median line. The measurements did not give any clearer impression than that given by the fulness in the infraclavicular fossa.

The X-ray showed a fracture through the surgical neck of the scapula with very little displacement. The treatment was similar to that in Case II. The result was a perfect restoration of function at the end of sixteen weeks with no evident disability or deformity (Figs. 1 and 2).

CASE II.—Joseph W., aged twenty-four, policeman, was admitted to the First Surgical (Cornell) Division of the New York Hospital on August 26, 1913, with a history of having been thrown and trampled upon while attempting to stop a runaway horse. The patient believes that he struck the left shoulder when he fell.

Examination.—There was complete inability to move the left shoulder-joint because of pain. There was a slight but definite flattening of the left deltoid region below the acromion as compared to the opposite shoulder, and the left infraclavicular fossa was smaller and less evident, especially on its outer aspect, than



FIG. 1.—Case I. Note the absence of any appreciable deformity; left shoulder.



FIG. 2.—X-ray of Case I. Note line of fracture through the surgical neck with very little displacement.



FIG. 3.—Case II. Note the prominence of the acromion and slight flattening of the left deltoid region.



FIG. 4.—X-ray of Case II. Shows the increased displacement. One year after injury shows the bony union better than earlier pictures.



FIG. 5.—X-ray of Case III. Note greater displacement than in above cases with fracture of the body of the scapula.



FIG. 6.—X-ray of Case IV. Note displacement and lines of fracture through the body and spine of scapula.



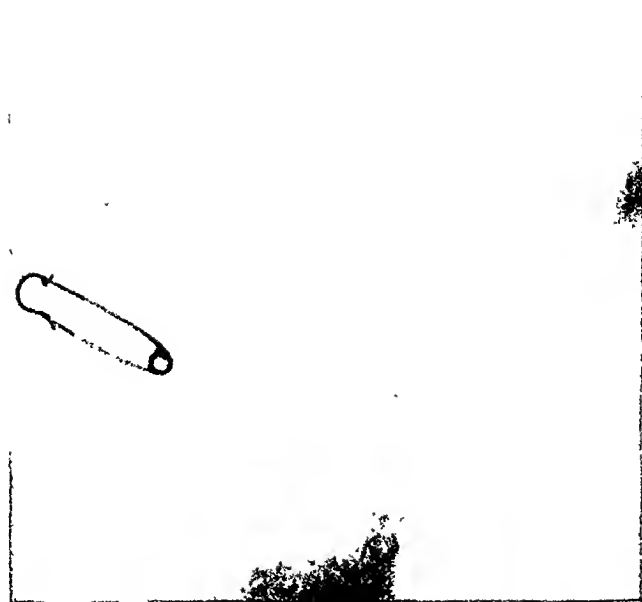
FIG. 7.—X-ray of Case VIII. Note the variation of the line of fracture through the surgical neck and compare with Case VII (Fig. 10).



FIG. 8.—Case VI. Note deformity at left shoulder.



FIG. 8a.—Case VI. Function six months after injury.



FIGS. 9 and 9a.—X-rays of Case VI. Show degrees of displacement and bony repair.



FIG. 10.—X-ray of Case VII. Note the complicated lines of fracture, especially that from the notch to the glenoid fossa.

the right. On palpation the head of the humerus rotated with the shaft and was in normal relationship with the other bony landmarks of the shoulder. As compared to the right side the acromion process seemed more prominent, and the bulge of the humeral head seemed to extend farther under it. There was no ecchymosis.

There was diffuse tenderness over the coracoid process and from there down through the apex of the axilla, increased by all passive movements of the arm, but especially by movements in the external rotation. Extension of the forearm against resistance gave very little pain, while flexion of the forearm against resistance gave pain in the infraclavicular fossa. Traction downward and pressure upward upon the elbow had no effect upon the position of the humeral head in its relationship to the acromion. Movement of the shoulder gave an indefinite crepitus best felt in the infraclavicular fossa and in the apex of the axilla. Elevation and depression of the scapula (whole shoulder girdle movements) against resistance caused no definite pain.

The X-ray showed a line of fracture through the neck of the scapula which ran from the suprascapular notch to the axillary border of the scapula about a half inch from the edge of the glenoid fossa. There were radiating lines of fracture in the body adjacent to fracture in the neck.

Reference to the description of the treatment as given by writers upon injuries of this nature stated that the deformity could be corrected by correcting the constant tendency to downward displacement by elevating the arm (Stimson, *Fractures and Dislocations*, 1912, p. 230).

This was tried and found to be a failure, inasmuch as no pressure upward nor traction downward upon the humerus had any effect whatsoever upon the position of the head of the humerus or the fragment involved in the fracture. (This latter was, of course, only determinable by the X-ray.)

Traction in the elevated and abducted position (Pringle, Grüne, Bardenheuer) likewise caused no change in the condition as demonstrable by change in the deformity or by the X-ray examination. In short, no manipulation or traction had any effect upon the lesion in question, and all of the above were abandoned for a Velpeau bandage.

Massage and baking were begun in the third week and passive motions one week later. At the end of eighteen weeks function was practically identical in both arms. Bony union occurred, as determined by the X-ray at the same time.

CASE III.—James M., aged forty-six, was admitted to the

First Surgical (Cornell) Division of the New York Hospital, January 6, 1914, with a history of having fallen twenty feet on his left side with his left arm against his side. This was followed by pain in the shoulder, and complete inability to use the arm.

Examination showed, among other contusions, one over the posterolateral aspect of the left shoulder just below the acromion. There was no ecchymosis except that directly above the contusion.

Deformity.—The bulge of the humeral head is less prominent than that on the opposite side, with slight flattening of the left deltoid region just below the acromion, the edge of which seems more prominent than that on the right side. The left infraclavicular fossa is slightly fuller than the right.

Disability.—Complete: Active motion is restricted to practically no movement of the arm. The head of the humerus rotates with the shaft but seems slightly further below the acromion than that of the other side. The coracoid process could not be felt.

Pain was elicited by direct digital pressure in the infraclavicular fossa (coracoid region), by pressure high up in the axilla, along the spine of the scapula, and in an irregular line over the body of the scapula below the spine. Pain was also elicited by pressure inward against the left shoulder (*i.e.*, crowding the shoulder together), the pain being localized in the infraclavicular region and over the left lateral thoracic wall. (The patient had fractures of the second, third, fourth, and fifth ribs.)

All attempts at passive motions of the arm caused pain in the infraclavicular region and high up in the axilla. Traction in all directions and pressure upward caused no change in the position of the head of the humerus in its relation to the acromion process.

Measurements.—From the posterior tip of the acromion to the external condyle showed the following: Left shoulder, 30.5 cm.; right shoulder, 31.0 cm.; *i.e.*, a shortening of 0.5 cm. on the affected side. A Velpeau bandage was applied and the treatment was similar to that of Case II. At the end of six months there was no detectable disturbance in function except the merest restriction in internal rotation of the shoulder. At this period there was likewise only the very slightest difference in the outline of the shoulder. One could hardly detect it.

Measurements.—From the coracoid to the mid-sternal notch gave the following measurements: Left side, 16.0 cm.; right side, 16.25 cm.; *i.e.*, the left coracoid was pushed 0.25 cm. nearer the median line.

The X-ray showed a fracture of the surgical neck of the scapula with a fracture through the body below the spine of the scapula and the fractures of the ribs above mentioned. The

FRACTURES OF THE NECK OF THE SCAPULA

glenoid fragment was displaced more than in the two preceding cases, and the fracture lines overlapped distinctly.

CASE IV.—Alexander D., aged thirty, plasterer, was admitted to the House of Relief, New York Hospital, Service of Dr. F. W. Murray, on July 5, 1914, with the history of having been caught between an elevator and a projecting beam.

The record at the House of Relief states that the left shoulder was swollen and all active and passive movements were restricted by pain, especially marked over the coracoid region where crepitus was felt. There was no note of ecchymosis, pain, or digital pressure, etc.

He came under observation at the Fracture Clinic of the First Surgical Division of the New York Hospital on July 23, 1914, with the arm in a Velpeau bandage.

Examination (eighteen days after injury).—At that time the left shoulder seemed slightly less rounded than the right. The acromion process was distinctly more prominent on the left side. The left infraclavicular fossa was less distinct than its opposite. There was pain on pressure over the coracoid region, and pain referred to the infraclavicular fossa on pressing inward over the head of the left humerus.

All movements, active and passive, were restricted and painful, the maximum pain being referred to the infraclavicular fossa and the summit of the axilla.

There was no evidence of ecchymosis at this time except some over the deltoid region just beneath the spine. There was also no disturbance between the relationship of the head of the humerus and the acromion process.

Measurements from the tip of the acromion to the tip of the external epicondyle showed no difference on the two sides.

The X-ray showed a line of fracture through the surgical neck of the scapula. There was also a line of fracture in the body which ran from the above line of fracture transversely to the vertebral border of the scapula, and an additional line of fracture from the last-mentioned fracture upward through the spine of the scapula to the superior border of the scapula.

The treatment was similar to that described for Cases II and III, with a complete restoration of function in eighteen weeks.

Result.—No distinguishable deformity or disability at the end of six months.

CASE V.—John H., aged thirty-one, admitted to the accident ward of the New York Hospital, November 11, 1908, with a history of having fallen on the left shoulder. There was inability to move the left shoulder and pain in the whole shoulder-joint.

Pressure high up in the axilla along the axillary border of the scapula gave a point of tenderness which was increased by extension of the forearm against resistance. The bony landmarks were in normal relationship.

X-ray showed a fracture of the lower third of the glenoid with displacement of the fragment downward. The arm was put up in a Velpeau bandage. The patient did not return for further treatment.

CASE VI.—John S., aged twenty-three, packer, was admitted to the Out-Patient Department of the House of Relief of the New York Hospital, on August 25, 1913, with a history of having fallen from a wagon forty-eight hours before coming to the hospital.

Examination was negative except for the left shoulder, which was the seat of a fairly extensive ecchymosis. There was marked flattening of the shoulder with prominence of the acromion as compared to the opposite shoulder. Disability was marked and painful, and active movements were limited in all directions. Passive movements were free but quite painful, and extension of the forearm against resistance caused pain referred to the axilla and the shoulder-joint. Flexion of the forearm against resistance caused no localized pain. The whole region of the shoulder-joint was painful, and a sense of an indefinite crepitus was obtained in the axilla upon to-and-fro movements of the shoulder.

A Velpeau bandage was applied for three weeks. At this time the deformity was noticeably increased and the head of the bone seemed to have fallen farther away from the acromion process. Movements in abduction seemed to show contraction in the deltoid muscle (evidently an erroneous observation). Two weeks later, *i.e.*, five weeks after the accident, there was evident atrophy of the deltoid with a definite electrical reaction or degeneration only obtainable by the use of a very strong galvanic current. Massage and galvanism were used at irregular intervals, due to the patient's failure to attend the clinic (New York Hospital Out-Patient Department) up to December 19, 1913.

On December 19, 1913, he was admitted to the New York Hospital and a thorough electrical examination showed a beginning return of motor function in the circumflex nerve, although a much stronger current was necessary to cause the contraction of the deltoid on the left side.

One year after the injury function was practically perfect on both sides, although there was still some atrophy of the left deltoid. The head of the bone on the left side seemed at about the same level in its relationship to the acromion as that of the right side.

FRACTURES OF THE NECK OF THE SCAPULA

The interesting feature of the case was the inability to correct the deformity by lifting up the arm as described in practically every description we have seen in lesions of a similar character. Later, when the deltoid paralysis became more pronounced and the dropping of the humeral head more evident, pressure on the elbow in raising the arm overcame the downward displacement of the head.

With the return of deltoid function the deformity practically disappeared, although no change in the line of fracture was obtained by the treatment, *i.e.*, the bone healed in identically the same position it occupied after the injury.

X-rays were taken at frequent intervals. The first showed a line of fracture (Figs. 9 and 9a) which began just above the centre of the glenoid fossa and extended down through the neck to the axillary border of the scapula. The separation of the fractured fragment is well shown in the X-ray. Sixteen weeks after the injury the fragment was united by bone along the line of fracture, except at its lower third. One year after the injury, bony union was complete throughout.

It will be seen from the location of the line of fracture in the X-ray picture that the circumflex nerve was evidently injured by the displaced fractured fragment. At no time was it possible by high axillary palpation to determine any thickening of the scapula at the line of fracture along the displacement, although the amount of bone required for the repair process seemed likely to give such thickening.

CASE VII.—Miss Theresa J. N., aged fifty, was admitted to the Private Pavilion of the New York Hospital, on March 15, 1915, with a history of having fallen or jumped out of a five-story window.

Among a number of other injuries was that to the left shoulder. The left shoulder was markedly altered in appearance, the deltoid contour being less rounded than its fellow, and the shoulder lower. There was marked prominence of the outer end of the clavicle, and the acromion on that side seemed more prominent and also tilted slightly forward.

There was a contusion over the scapular region behind with fairly extensive ecchymosis in this region and also over the deltoid region and along the inner aspect of the chest wall in the post-axillary line.

It was difficult to determine painful areas, as the whole shoulder was painful. It could be readily determined that there was a dislocation of the outer end of the clavicle, a line of fracture in the spine of the scapula, and pressure over the coracoid region gave a definite bony crepitus.

Measurements from the acromion to the external epicondyle showed no change in the position of these bony points as compared to the opposite side, although the shoulder was distinctly lower than its fellow. Raising the arm corrected this downward displacement and the dislocation of the clavicle.

The arm was dressed in the adhesive plaster dressing of Stimson and a starch Velpeau.

X-ray (Fig. 10) shows a line of fracture from the suprascapular notch through the base of the coracoid to a little below the middle of the glenoid fossa. In addition it also shows a fracture of the base of the acromion process and a dislocation of the outer end of the clavicle.

The patient last came under observation in June, 1915, three months after the injury, and at that time there was fairly marked disability, motion being restricted in all directions. Passive movements could be executed to a little beyond a half of the normal.

(Due to a definite mental condition and the difficulties resulting from it, all our methods had to be modified at different times throughout the treatment.)

CASE VIII.—Wm. Mc., aged thirty, a patient of Dr. Charles Farr, to whom we are indebted for the history and pictures of the case, fell from a wagon, injuring the right shoulder. It was put in plaster for five weeks. At the end of three months there was no appreciable deformity and there was a fair functional result.

The X-ray shows a type of fracture which is intermediate in its grouping between Cases I, II, III, IV and VII, and is an interesting variation from the ordinary type of scapular fracture of the surgical neck. The line of fracture runs through the surgical neck, but in addition there is a separate line of fracture which has split off a fairly large fragment of the glenoid fossa and displaced it into the axilla. This case, we believe, should be included among the fractures of the surgical neck of the scapula and should be described as a variation of that type of injury.

ANALYSIS OF THE CASES

The fractures of the neck of the scapula fall into the following groups:

I. *Fractures of the Surgical Neck* (Cases I, II, III, IV and VIII).—In these the line of fracture begins in the suprascapular notch and runs to the axillary border of the scapula at or below the infraglenoid tubercle. This is the most frequent type in our series. Tanton states that the line of fracture may be complete or incomplete. Ours were all complete. There may be little or no displacement. Grüne

FRACTURES OF THE NECK OF THE SCAPULA

cites ten cases of this type, nine of which showed no displacement. All of our cases showed some displacement of the fractured fragment inward, as shown by the X-ray. This was the least in Case I, and most marked in Case IV. Case I showed no other line of fracture than that through the surgical neck. Case II showed some irregular lines of fracture in the body of the scapula adjacent to the neck, while Cases III and IV showed lines of fracture extending clear across the body of the scapula and involving the spine of the scapula.

Cause: In all of the cases the injury resulted from a blow received upon the shoulder. In Case I, the only one in which it was definitely determinable, the impact was received against the point of the shoulder just a little behind the centre. In this case the impact was relatively slight, the patient falling only a portion of his length. In the other three cases all were types of a severe injury, Case II being due to the impact of a running horse throwing the man against his shoulder; Case III, a fall of twenty feet; and Case IV, a crush between a moving elevator and a projecting beam. In these three cases there was also a coincident fracture of the body of the scapula, and that coincident fracture was most extensive in the cases (III and IV) in which the violence was the most extreme.

Symptoms: 1. Deformity: In none of these cases was there any deformity which might be described as characteristic. All showed a little flattening of the deltoid, some prominence of the acromion, and a change in size of the infraclavicular fossa, *i.e.*, that fossa was smaller and more filled in than its opposite.

2. Ecchymosis was absent except in one case which had a contusion over the deltoid region. Later, extravasation of blood appeared as a yellow stain high up in the axilla, and in the infraclavicular fossa in all the cases.

3. Disability was complete in all the cases.

4. Pain was present on direct digital pressure over the coracoid region in all the cases. There was also pain on pressure high up in the axilla in two of the cases. Cases III and IV (those with additional lines of fracture through the body) gave pain on direct digital pressure along the line of these fractures.

On crowding the head of the bone inward, pain was elicited in the infraclavicular fossa and high up in the axilla. Pressure upward on the elbow gave no pain if care was taken to avoid any movement of the arm during the manipulations. In Cases III and IV, pressure on the upper and lower angles of the scapula gave pain along the line of the digital pressure pain.

Extension of the forearm against resistance gave very little distress and it was diffuse rather than localized. Flexion of the forearm against resistance gave pain of a variable degree localized to the infraclavicular fossa.

5. There was no change in the relationship of the head of the humerus to the acromion, the head rotated with the shaft, and pressure upward and traction in all directions caused no change from the normal. In two of the cases a note is made that the head seems further beneath the acromion.

6. Passive motions were restricted to almost no movement before pain began to limit them.

Diagnosis: The points in diagnosis which would suggest a fracture of this type are, (1) a fall upon the shoulder followed by a disability at that joint with the pain localization described under symptoms (Paragraph 4), and the absence of a change in the head of the bone in its relationship to the acromion, its rotation with the shaft in this position, and the inability to influence that position by manipulative efforts upon the arm.

While all of the above facts would strongly suggest a fracture in the surgical neck of the scapula, its actual presence must be confirmed by a suitable X-ray picture before the diagnosis can be said to be completely established. Naturally enough, an autopsy in fatal cases would give the needed confirmation if an X-ray were absent.

In all four of the above cases the diagnosis was made clinically, Cases I, II and IV, coming as they did after Case II, were not difficult, but we were not positive of our diagnosis until we had seen the X-ray.

II. *Fractures of the Lower Half of the Neck of the Scapula.*—In this type the line of fracture begins at or below the middle of the glenoid fossa, extending downward obliquely through the neck to the axillary border of the scapula. Our series contains two cases of this type which are similar to the case described by Spence.

Cause: The cause given in both cases was a fall upon the shoulder. Both patients were intoxicated when the injury was received, and no definite statement of the nature of the fall could be obtained. In neither case was there any local contusion to explain the point of impact. The position and the direction of the line of fracture suggest strongly that the fracturing force was received upon the anterior point of the shoulder and transmitted through the head of the bone downward. (Attempts to produce this lesion by this mechanism in the cadaver failed, and fracture of the head occurred.)

Symptoms: There was no deformity in one case except the swelling

of the shoulder girdle. In the other there was marked flattening of the shoulder due to a coincident circumflex nerve injury.

Ecchymosis was present in one case and absent in the other. In the case in which it was present the whole shoulder region and the axilla were involved in the extravasation.

Disability was complete in both cases.

Pressure against the shoulder, *i.e.*, crowding the shoulders together, gave pain localized to the shoulder region, and especially high up in the axilla.

Movements of the arm against resistance: Pain localized high up in the axilla was present in extension of the forearm against resistance, and absent in flexion against resistance.

Crepitus: An indefinite crepitus was obtained by to-and-fro movements of the arm at the shoulder. No crepitus similar to that described by Ashhurst in his case could be obtained.

There was no change in the bony relationships except in one case in which the head of the bone was perceptibly lower in its relationship to the acromion (deltoid paralysis). This increased perceptibly as the paralysis became more pronounced.

Passive movements were restricted to about one-third the normal range of motion, and were painful.

Traction downward and pressure upward upon the arm did not affect one case. In the other these movements, due to the deltoid paralysis, did alter the position of the head, in that it would come farther away from the acromion in downward traction, and could be brought closer to that process when the arm was lifted upward, a phenomenon which was not due to the bone lesion, but was due to the circumflex nerve injury.

In one case there was a coincident deltoid paralysis which reached its maximum five weeks after the injury and which, we believe, was responsible for such deformity as occurred in this case. Return of nerve function began four months after the injury and eventually became complete, although there was still some atrophy of the deltoid on the left side with its coincident degree of weakness in the muscle.

Diagnosis: The same remarks apply in this type as are given under Type I.

III. *Fractures of the Neck of the Scapula Beginning at the Notch and Extending Downward Through the Base of the Coracoid Process to the Glenoid Fossa.*—This type is represented in the literature by Braun's case which Stimson has included under the fractures of the coracoid process. It is represented in our series by Case VII, and we

believe it should be included in the fractures of the neck of the scapula. One can readily see a reason for this by comparing Case VIII, which is similar to this type except that there is an additional line of fracture to that given for this group, which extends through the surgical neck and makes a separate fragment of that portion of the glenoid and surgical neck which remains unbroken in this type.

The same remarks apply here in determining the diagnosis as were given under that heading under fractures of the surgical neck.

Treatment: The only treatment we found to be essential was rest and this was best obtained by a Velpeau bandage. All the other forms of treatment had no effect upon the bone displacement. The arm along the head position described by Grüne and pictured by him and Bardenheuer, and the abducted position described by Pringle were used in Case II. The only possible benefit that might accrue from this position is the more rapid restoration of abduction. This is in turn counterbalanced by the necessity for keeping the patient in bed, a form of procedure we did not find essential to a perfect functional result.

The Velpeau bandage should be worn from three to four weeks, massage and baking begun on the third week, and passive and active motions with the removal of the bandage. The too early use of motion gained nothing, in our experience, and we believe that such motion as is permitted should be restricted to movements which are not painful.

Result: Bony union occurred in Cases I, II, III, IV and VI. The character of the union is unknown in Cases V, VII and VIII. Cases VII and VIII are reported as satisfactory but there is no X-ray evidence.

Function was practically perfect in Cases I, II, III, IV and VI. Case V disappeared. In Case VIII it is stated as fair. In Case VII function is reported as distinctly limited and movements of the arm are accompanied by pain.

IV. *Fractures of the Anatomical Neck.*—We could find no authentic case of this type. Plageman reports three cases of fractures of the anatomical neck. He does not show any of the X-ray pictures from which he states the diagnosis was made, and the diagnosis given in his text lacks confirmation in the experience of any other writer upon this region. We are therefore inclined to doubt the existence of such a fracture.

V. *Stellate Fractures of the Glenoid Fossa of the Scapula.*—We have seen none of this type. The literature (*vide infra*) contains the cases at present reported.

VI. *Fractures of the rim of the glenoid with or without fissures run-*

FRACTURES OF THE NECK OF THE SCAPULA

ning into the neck are frequent in dislocation of the shoulder. They are, however, complicating injuries in dislocations and for that reason we have not included our cases nor the literature upon this subject in this paper.

ANATOMICAL EXPERIMENTS

Because the cases observed by us seemed to differ so materially in their clinical manifestation from the descriptions of such lesions as given by the various writers upon fractures of this region, a group of fracture experiments were made upon cadavers placed at my disposal by Dr. Stoddard in the anatomical laboratory of the Cornell Medical School.

The scarcity of anatomical material and the remote possibility of being able to produce a clear-cut type of the bone lesion by external violence applied to the shoulder region led me to make the fracture line to be studied with an osteotome. Such attempts as I did make resulted in fracture of the neck of the humerus. The lines of fracture produced in these experiments were confined to the types we had seen in the clinical cases, *i.e.*, (1) fractures of the surgical neck, (2) fractures of the lower half of the glenoid fossa, (3) fractures of the upper half of the glenoid fossa through the suprascapular notch.

Experiment I.—Aged female, right shoulder. After exposing the suprascapular notch from behind and above by removing the trapezius muscle, the neck of the scapula was fractured from the notch to the axillary border just below the glenoid tubercle with an osteotome, thus producing the type we had observed most frequently in the clinical cases.

By pressure over the joint of the shoulder the head of the bone was pushed a little farther beneath the acromion and the coracoid process somewhat closer to the midline. There was, however, no dropping of the head away from the acromion which could be corrected by lifting the shoulder upward. Traction in the cadaver allowed for certain slight displacements in various directions which could be explained by the stretching of the dead tissue, but this traction did not correct the displacement of the fractured fragment. This indeed seems most likely since the deformity is one of displacement mesialward of the whole shoulder-joint, and such deformity as occurs is due to the displacement of the head inward and very slightly forward, displacement being governed by the conoid and trapezoid ligaments, and coraco-acromial ligaments.

When the deltoid muscle was cut transversely the head dropped down 1 cm. This deformity was corrected by lifting up the elbow. The degree of downward displacement increased when the supraspinatus and the long head of the biceps were cut, and became much more pronounced when the joint was opened.

When the coracoclavicular ligaments were cut there was an increase in the width of the gap between the coracoid and the clavicle, and a deformity appeared in the acromioclavicular joint, but no change occurred in the relationship of the humeral head and the acromion.

All these facts correspond with the statements of Fick, Morris, and the anatomists that the shoulder-joint is dependent upon the muscles and the atmosphere for its stability. With these muscles intact and the shoulder-joint unopened a fracture through the neck of the scapula does not produce a deformity which can be influenced by the methods described for the treatment of this type of fracture.

Dissection showed that the glenoid fragment was displaced very slightly inward and the fractured surface of the neck was anterior to and slightly overlapped the line of fracture in the body. This corresponds to the displacement in Morestin's case. The amount of this displacement mesialward was controlled by the coraco-acromial and the coracoclavicular ligaments, especially the former. It was difficult to estimate the amount of tearing of the coraco-acromial ligament which was essential to increased displacement, but by partially severing it an increase of 0.5 cm. could be made in the displacement mesialward.

This would strongly suggest that in the cases with much displacement the coraco-acromial ligaments are more or less torn.

Experiment II.—Exposure of the suprascapular notch as in Experiment I. With the osteotome a fracture line was made through the notch to the middle of the glenoid behind the base of the coracoid.

When this was done there was no appreciable change in the shoulder contour. Pressure was then made upon the head of the humerus by crowding it inward without producing any appreciable change at the shoulder other than a slight increase in the prominence of the coracoid process. Traction upon the arm caused a little change at the outer end of the clavicle which seemed to become very slightly more prominent, a fact which might be explained by the stretching of the dead tissues. Pressure over the coracoid gave a certain amount of mobility not present on the opposite side. When the deltoid, supraspinatus, and biceps were cut and the joint opened, the same phenomena which were described in Experiment I occurred. When the conoid and trapezoid ligaments were cut the outer end of the clavicle became more prominent, and this prominence increased when the capsule of the acromioclavicular joint was opened. All the above could be corrected by raising the arm upward, but, as can be seen, all the displacements were due to other forms of injury than the fracture and practically no effect resulted from raising the arm or from traction upon it when the fracture alone existed. Dissection showed very little displacement along the line of fracture other than a tilting forward of the lower end of the coracoid fragment.

The case in our series was not a simple fracture of the above type, but combined a dislocation of the outer end of the clavicle (rupture of the coracoclavicular ligaments) and the deformity was really due to that injury.

Experiment III.—Fracture line from the middle of the glenoid fossa to the axillary border of the scapula (type of Cases V and VI in our series).

It was more difficult to produce this type, inasmuch as approach to the area it was desired to fracture meant disturbance of some of the muscle relationships at the joint and also allowed the entrance of air into the joint unless considerable care was used. The method of approach which caused the least disturbance was that from the back, cutting through the infraspinatus and teres minor to a degree sufficient to allow the osteotome to be used.

A line of fracture was then made which compared very favorably to that

FRACTURES OF THE NECK OF THE SCAPULA

of our Case VI, *i.e.*, from just above the middle of the glenoid to the axillary border along the attachment of the triceps. There was no change in the position of the head of the bone and no change in shoulder contour. Pressure downward upon the head and traction upon the arm produced some displacement of the head due to the stretching of the dead tissue. Cutting the deltoid, etc., as described in Experiment I, produced the same increase in the displacement described there. Raising the arm did not change the position of the fragment. Traction on the arm in the abducted position produced a further widening in the gap between the fractured surfaces. In the cadaver it was possible to feel this movement in the fragment by high palpation in the axilla, and to confirm it by watching the movement of the fragment from the opening made in the back to produce the fracture.

From the above-mentioned clinical observations and anatomical experiments we may conclude:

1. That the description of the deformity resulting from fracture of the region of the neck of the scapula as ordinarily given is not correct and that fracture in this region may occur without any recognizable deformity.

2. That the clinical manifestations of the fracture are insufficient to make a positive diagnosis, and that the X-ray is an essential factor in the diagnosis.

3. That immobilization of the arm by a Velpeau or similar bandage is all that is essential, and that no manipulative efforts have any effect upon the displacement which occurs at the line of fracture.

4. That massage, baking and careful attention to the after-treatment will give practically perfect functional result.

5. That the resulting function is so satisfactory that ill-advised attempts at correction are to be condemned. Should a type of fracture occur in which the displacement actually promised a bad functional result, the fracture line could be best approached from behind and the glenoid fragment pried into position in this way with correction of the coincident injuries by appropriate methods (repair of ligaments, etc.).

LITERATURE—REPORTED CASES

The literature is replete with fairly numerous cases reported as fractures of the regions under discussion. We propose to classify these cases into three classes, namely, specimens and autopsy reports, cases with X-ray confirmation, and clinical cases without either of the above types of confirmation, because we do not feel that those cases in which the diagnosis rests upon clinical evidence alone, unsupported by postmortem, X-ray, or operative confirmation, can safely be included in any collected list of such injuries.

TYPE I.—*Fracture of the surgical neck:*

CASE I.—Baudoin describes a prehistoric specimen. In excavating at Belleville a burial chamber of the Neolithic Period among other abnormalities in the bones of about fifty skeletons, a scapula was found showing an evident fracture of the surgical neck. Report was made on account of the evident rarity of the injury, and from the fact that there is not a single museum specimen in France. Repair had been complete, but from the remains of the callus it was evident that the fracture had detached the glenoid in its entirety with a small part of the axillary border of the scapula. There was also a fracture of the base of the coracoid. The distal fragment was displaced inward and backward, the glenoid cavity being rotated backward on its vertical axis. Posterior to the glenoid there was thrown out a peri-articular wall of bone by means of which the function of the joint had evidently been preserved. As there was evidence of complete repair, it follows that there can be a spontaneous cure, for at this period there was no rational therapeutics.

CASE II.—Similar to Case I is the specimen in the Royal College of Surgeons, mentioned by Flower. In this case also there had been complete bony repair.

CASE III.—Thomas Bryant illustrates a specimen (No. 1097) in Guy's Hospital Museum. The fracture line extends from a little to the inner side of the suprascapular notch to below the glenoid.

CASE IV.—Mott, Valentine: A specimen of fracture of the neck of the scapula. The clavicle was also fractured.

CASE V.—Du Verney: A girl of twenty fell into a quarry, where she was found dead. Autopsy revealed fracture of the neck of the scapula including the coracoid, there being a complete separation from the remainder of the bone. This is the first recorded case verified by dissection.

CASE VI.—Neill exhibited before the College of Physicians of Philadelphia a specimen of healed fracture of the scapula, the fracture involving the glenoid cavity and running longitudinally through the neck so as to traverse the base of the coracoid and spinous processes and a portion of the upper margin of the bone. The specimen illustrated the manner in which the repair of the bone had been effected.

CASE VII.—Morestin describes a specimen from a cadaver, there being no history. The cause of death was pulmonary tuberculosis. Exterioirly there was no sign of injury nor was there any limitation of motion. The line of the fracture extended from the suprascapular notch to 3 cm. below the glenoid and apparently had been slightly oblique, from behind forward and outward. The distal fragment had ridden slightly over the proximal and union had occurred in this position. The ligament across the suprascapular notch had *not* been ruptured, nor apparently had the conoid, trapezoid, and coracoid ligaments.

CASE VIII.—Cavaye: A workman while raising a huge stone was struck on the shoulder from behind by the lever. At autopsy, in addition to other injuries, was found a line of fracture extending from a little within the suprascapular notch to a point 2 cm. below the glenoid, skirting the base of the coracoid.

CASE IX.—Cotton: Radiograph of fracture of the surgical neck. There was no history of the case.

FRACTURES OF THE NECK OF THE SCAPULA

CASE X.—Scudder: Radiograph of fracture of the scapula behind glenoid.

CASES XI-XX.—Grüne reports ten cases of fracture of the surgical neck of the scapula, diagnosis confirmed in every case by radiograph. In only one was there any displacement. In this one the distal fragment was drawn up over the proximal, as in the specimen described by Morestin, though to a less extent. Deformity was usually absent but when present was limited to a slight flattening of the deltoid. He calls attention to the fact that this fracture may result from relatively slight trauma. In one of his cases a woman of sixty fell out of bed on her right shoulder. He describes a case in which the fracture was the result of indirect violence. A laborer was carrying one end of a heavy load when his helper suddenly dropped the other end. In an attempt to hold up the weight alone, he felt a sudden pain in the right shoulder and heard a crack. X-ray showed a transverse fracture of the neck of the scapula. The published radiographs are so indistinct that it is impossible to make out the line of fracture, but from the description it is evident that the fracture was unusually incomplete and that the line was not always in what is usually understood by the term "surgical neck." In diagnosis he emphasizes tenderness to pressure in the region of the scapular neck. In the treatment he uses dorsal decubitus with traction in extreme abduction after the method of Bardenheuer for ten to fourteen days, usually with passive motions daily. Subsequently passive motions and massage.

The results were excellent, there being practically perfect function in all but one case, usually in three to six weeks.

CASES XXI-XXIII.—Plageman reports three cases from radiograph, but does not give details nor reproduce the pictures.

In addition to the well-authenticated cases described above there are numerous reports of cases in which the diagnosis rests upon clinical evidence alone. Among these may be mentioned the reports of Alix, Broadhurst, Bramwell, Brown, Bell, Cross, Dugas, Ashhurst, Skey, Stimson, Harris, Monagan, Fitzgerald, Parker, Gerster, Stillings, Holmden, Hamilton, Bulloch, and Longlet. In a large proportion of these cases the injury resulted from a severe trauma and was complicated. In four cases there was more or less complete paralysis of the upper extremity from injury to the brachial plexus; in five cases there was some interference with the circulation; in two there was a coincident fracture of the upper portion of the humerus; in one a fracture of the outer end of the clavicle.

The liability to error in a diagnosis which rests alone upon physical signs may be deduced from the fact that of three of the cases upon which Sir Astley Cooper based the picture of this condition which has since become classical, the two which subsequently came to autopsy proved to be fractures of the upper extremity of the humerus.

Summary.—Cases confirmed by specimens and autopsy, 8; cases confirmed by X-ray, 15; total, 23. Our cases, 5; total, 28.

TYPE II.—*Fracture of glenoid, line of fracture extending from within the glenoid cavity to the axillary border of the scapula:*

CASE I.—Spence and Steel report the case of a man who, while intoxicated, injured his shoulder by a fall. The deformity was that of the classical fracture of the surgical neck of the scapula, and the normal contour of the shoulder was restored by upward pressure on the elbow, the restoration being accompanied by crepitus. The patient died on the nineteenth day from a coincident head injury.

At the autopsy the concourse of the scapular fracture extended diagonally upward and downward from about $\frac{1}{2}$ cm. back to the origin of the long head of the triceps, and separated the neck as well as the lower four-fifths of the articular surface of the glenoid. The long head of the biceps and the whole glenoid ligament were torn from the upper remaining fragment of the articular cavity as well as from the otherwise injured capsular ligament, and had followed the displaced portion, thus separating all the articular structures from the scapula and drawing them downward.

CASE II.—Struthers: A woman of twenty-one tripped while walking and fell on the front of her shoulder. Examined four days after the injury. Complained of pain and disability in the right shoulder. There was noticeable absence of swelling and ecchymosis. Close inspection only revealed deformity, a slight flattening of the deltoid. Complete loss of power of voluntary motion, not due to paralysis of muscles, as they could be felt to contract. The fracture line extended from just below the middle of the glenoid to the upper portion of the axillary border. The fracture was evidently caused by the head of the humerus being driven against the fossa, detaching the lower portion. The head of the humerus had not fallen, being presumably held by the upper portion of the joint capsule, the long tendon of the biceps, and the supraspinatus. The treatment was daily passive movements, massage, and, on account of discomfort, a sling for a few days. The patient was encouraged to use the arm as much as possible. Three weeks after injury she could swing the arm to vertical but could raise or lower it slowly. Seven weeks after the injury she could lift or lower the arm slowly without limitation of range, but the arm was not quite so strong as on the sound side.

CASE III.—Beasley reports the case of a man who came to him after having been treated for fracture of the surgical neck of the humerus. The left arm was wasted and had no motion save a very limited one forward and backward. The humerus was intact, rotating freely in joint cavity, but on attempt at elevation seemed locked at upper end. There was felt in the axilla a fragment from the glenoid. The radiograph showed a fragment broken from the lower end of the glenoid which had dropped down and had been lifted up just enough, when united, to push up the head of the humerus against the acromion, blocking it. Under ether the adhesions were broken up and the fragments pushed into place, after which the arm could be put through the normal range of motion. Passive motion in one week, and recovery.

Summary.—Cases confirmed by autopsy, 1; cases confirmed by X-ray, 2; total, 3. Our cases, 2; total, 5.

FRACTURES OF THE NECK OF THE SCAPULA

TYPE III.—*Fracture of the glenoid, fracture line extending from within the glenoid cavity upward and inward, usually including the coracoid:*

CASE I.—Braun found, in the course of an autopsy on a man who had been struck but not run over by a locomotive, a fracture of the coracoid process which included the upper portion of the glenoid cavity.

CASE II.—Avray reports autopsy on a case of severe injury in which, in addition to fractures of numerous ribs, there was a complex fracture of the scapula including the glenoid, the upper fragment being about $\frac{1}{4}$ inch wide and free from the coracoid, which was also fractured.

CASE III.—Preiser describes a type of fracture somewhat similar to the one described by Braun. It is also usually associated with a fracture of the outer end of the clavicle. The mechanism is peculiar: the patient, while carrying a burden, slips and falls, catching himself upon his arm stretched backward and somewhat abducted. As the arm is abducted and held backward the force falls, not on the acromion, but on the coracoid. The scapula being fixed by involuntary muscular action, the coracoid is torn off with the upper part of the glenoid. The fracture of the glenoid is usually star-shaped, the fissure extending through the supraspinal fossa either to the vertical border of the scapula or to the middle of the superior border. The coracoid strikes the clavicle and causes a tear of the acromioclavicular ligaments, causing a dislocation of the acromial end of the clavicle or, if these ligaments hold, a fracture close to the acromial end of the clavicle.

The second form (line extending from within the glenoid to the superior border of the scapula) is represented by the picture of a specimen in which the fragments had healed. He speaks of another case but states that the radiographs are not such as to permit reproduction.

CASE IV.—Kolliker gives a picture of a specimen, the counterpart of Preiser's cases. He says that the fracture of Preiser may be considered an incomplete fracture of the surgical neck and corresponds to the splitting off of the lower half of the glenoid, which can also occur only when the arm is in one definite position.

Summary.—Autopsy and specimens, 4; X-ray, 2; total, 6. Our cases, 1; total 7.

TYPE V.—*Fissure extending from within the glenoid cavity:*

CASE I.—Assaky: A man of twenty-five fell on his left shoulder. He was brought to the hospital, where the diagnosis of subcoracoid dislocation of the shoulder was made and the deformity reduced. Twenty-eight days later the patient died of pneumonia. At autopsy the head of the humerus occupied the glenoid cavity; there was no malposition nor tear of the capsule. A stellate fracture of the glenoid with three arms was found. Also there was a fracture of the acromion at the juncture of the neck with the spine. There was no evidence of consolidation in the fracture of the glenoid.

CASE II.—John Poland showed before the Hunterian Society a specimen of fracture of the glenoid from a man aged forty-six who had fallen a distance of about twelve feet, dying from injuries of the head. The glenoid cavity was

fractured in a stellate manner and three lines of fracture radiated from this in the body of the scapula. The acromion process was also broken, but there was no dislocation.

CASE III.—Plageman (*loc. cit.*) cites three cases from the study of radiographs described as fractures of the anatomical neck with fissures into the joint. He does not reproduce the pictures, and the diagrams do not seem to indicate the fracture line he describes.

TYPE VI.—*Fracture line extending immediately behind and parallel with the glenoid through that compact portion of bone on which the glenoid rests, which is called the "anatomical neck":*

The only cases of this type in which diagnosis was confirmed by X-ray or autopsy are the three cases mentioned by Plageman. The radiographs upon which the diagnosis was founded are not reproduced and the cases are not described individually. There is no anatomical specimen nor record of any autopsy of this condition. Cases in which diagnosis rests on clinical evidence alone are reported by Dugas, Hemenway, and Eales.

Since this paper was submitted for publication the following additional case has come under observation:

On November 1, 1915, an Italian laborer, forty years old, was carrying a small iron beam, over his right shoulder, down an inclined plane when he slipped and fell forward, the right shoulder being caught between the falling beam and the floor. He was removed in the ambulance to the Hudson Street Hospital, on the service of Dr. J. H. Kenyon.

There was marked swelling and some ecchymosis over the dorsum of the scapula; bony crepitus was distinct and there was an evident comminuted fracture of the body of the scapula. Disability was complete though passive motion was possible, at the expense of considerable discomfort.

On the third day after injury active motion of the shoulder-joint was possible to a limited extent and the complete range of motion could be carried out passively with slight discomfort. The swelling over the dorsum of the scapula persisted to some extent, but there was no flattening of the deltoid. Crepitus was elicited, but was evidently due to the fracture of the body of the scapula.

An adhesive band was placed over the scapula and the arm was carried in a sling so arranged as to support the elbow. After five days the adhesive was removed, the only subsequent treatment being a sling. After ten days he was encouraged to use his arm. Three weeks from the date of injury he could carry his arm through the full range of motion, complaining only of slight sore-

FRACTURES OF THE NECK OF THE SCAPULA

ness. One month after injury he complains of no pain, but thinks his arm is not quite as strong as it was before he fell.

This case was regarded as being merely a fracture of the body of the scapula, until the radiograph was seen. Even when we knew that there was in addition a fracture of the surgical neck we could make out no deformity of the shoulder and the only symptom was pain on motion.

The X-ray shows a fracture through the surgical neck (House of Relief No. 3134) with lines of fracture in the body adjacent to the neck similar to Case II in our series.

This additional case makes six cases of fracture of the surgical neck of the scapula reported by us and increases the total of the cases of this type to 29.

The following additional literature upon this subject has come to our notice since the presentation of this report:

Bonnet et Becquelin (*Bull. de la Soc. Anat. de Paris*, 1896, p. 845, 5 serie, vol. x): A laborer aged forty years was struck on the shoulder by a railroad truck weighing 2000 kilogrammes. In addition to other injuries there was found at autopsy, a fracture of the scapula. The bone was in two principal fragments, the smaller comprising the glenoid, the adjoining parts of the supra- and infra-spinous fossæ, the origin of the spine of the scapula and the coracoid. The latter was, in addition, fractured at the base.

Ziegler (*Muenchener Med. Wochenschrift*, April 18, 1899, p. 515) reports a case of fracture of the surgical neck of the scapula, which was complicated by rupture of the axillary artery and resulting gangrene of the upper extremity. The fracture was observed at the time of the amputation at the shoulder.

Tanton (*Nouveau Traité de Chirurgie*, by Le Dentu et Delbet, 1915, vol. iv, p. 794) reproduces radiograph of fracture of the surgical neck of the scapula and gives a good description of the lesion here discussed.

Lotzbeck (*Deutsche Klinik*, 1867, vol. xix, p. 420) reports two cases of fracture of the neck of the scapula, one of the surgical and one of the anatomical neck, the diagnosis resting on clinical evidence alone.

BIBLIOGRAPHY

- Alix, E.: *Moniteur des Hôpitaux de Paris*, 1856, vol. xxix, p. 86.
Ashhurst, John, Jr.: *Trans. Coll. Phys., Phila.*, 1874, 3rd S., vol. i, p. 69.
Assaky: *Bull. Soc. Anat. de Paris*, 1881, vol. lvi, p. 445.
Auvray: *Bull. et Mem. Soc. Anat. de Paris*, vol. lxxiv, p. 669.
Bardenheuer: *Lehrbuch*, Stuttgart, 1907.
Baudouin: *Arch. Prov. de Chir.*, Paris, 1909, vol. xviii, p. 574.
Beasley: *Railway Surg. Jour.*, Chicago, 1913, vol. xx, p. 202.
Bell, J. L.: *Med. and Surg. Reporter*, Phila., 1890, vol. lxii, p. 256.
Bramwell, J. P.: *Brit. Med. Jour.*, 1817, vol. ii, p. 70.
Braun, John: *Quart. Med. Jour.*, Sheffield, 1899, vol. viii, p. 31.
Braun: *Archiv. fur klin. Chir.*, vol. xlii, p. 110.

- Broadhurst, B. C.: *Med. Times and Gazette*, London, 1857, N. S., vol. xvi, p. 235.
- Bryant, Thomas: *Practice of Surg.*, 2d Edition, 1879, p. 783.
- Bulloch, W. S.: *Savannah Jour. Med.*, 1858, vol. i, p. 11.
- Cavaye: *Etudes sur les Fractures du Col de l'Homoplate et de la Cavité Glenoide*, Thèse de Paris, 1882.
- Cooper, Sir Astley: *Lectures on Principles and Practice of Surgery*, 3rd Edition, Boston, 1831, vol. iii, p. 147.
- Cotton: *Disloc. and Joint Fract.*, 1910, p. 145.
- Cross: *London Med. Gazette*, 1830, vol. vi, p. 414.
- Dugas, L. A.: *South. Med. Jour.*, 1857, N. S., vol. xviii, No. 6.
- Du Verney: *Traité des Maladies des Os*, Paris, 1751, vol. ii, p. 222.
- Eales, S. G.: *Lancet*, October 9, 1886, p. 671.
- Fitzgerald, T. N.: *Australian Med. Jour.*, Melbourne, 1883, N. S., vol. v, p. 157.
- Flower: *Holmes System of Surg.*, vol. i, p. 954.
- Gerster, A. G.: *N. Y. Med. Jour.*, 1884, xxxix, p. 389.
- Grüne: *Zeitschr. f. Orthopædische Chir.*, 1911, vol. xxix, p. 86.
- Hamilton, J. B.: *Internat. Clin.*, Phila., 1896, vol. iii, p. 222.
- Harris, Juriah: *Savannah Jour. Med.*, 1860, vol. iii, p. 73.
- Hemenway: *ANN. SURG.*, vol. vi, p. 85.
- Holmden, F. A.: *London Lancet*, 1895, vol. ii, p. 1498.
- Kolliker: *Zentralbl. f. Chir.*, 1912, No. 41, p. 1406.
- Longlet: *Union Med. du Nord et Rheims*, 1911, vol. xxxv, p. 31.
- Morestin: *Bull. Anat. de Paris*, 1894, p. 633.
- Monagan, Thomas: *Brit. Med. Jour.*, 1876, vol. i, p. 210.
- Mott, Valentine: *A Catalogue of the Surgical Collection of Valentine Mott and His Son, A. B. Mott*, 1858.
- Neill: *Am. Jour. Med. Sc.*, 1858, N. S., vol. xxxvi, p. 105.
- Parker, Rushton: *Brit. Med. Jour.*, August 22, 1885, p. 343.
- Plageman: *Beitrag. z. klin. Chir.*, 1911, vol. 73, p. 688.
- Poland, John: *Brit. Med. Jour.*, January 23, 1892, p. 175.
- Powell: *Inter. Jour. Surg.*, N. Y. 1898, vol. xi, p. 170.
- Preiser: *Zentralbl. f. klin. Chir.*, 1912, No. 26, p. 880.
- Pringle: *Fract. and Their Treatment*, Oxford University Press, 1910, Fig. 73, p. 236.
- Scudder: *Treatment of Fractures*, 8th Edition, p. 165.
- Skey, F. C.: *London Lancet*, 1860, vol. i, p. 368.
- Spence, J., and Steel, F.: *Edinburgh Med. Jour.*, June, 1863, p. 1082.
- Stillings, F. A.: *Trans. N. H. Med. Soc.*, Concord, 1888, p. 50.
- Stimson: *Fractures and Dislocations*, 1912, p. 230.
- Struthers, J. W.: *Edinburgh Med. Jour.*, 1910, N. S., vol. iv, p. 147.
- Tanton: *Jour. de Chir.*, 1913, vol. ii, p. 703-710; *Nouv. Traité d. Chir. (Le Dentu et Delbet)*, 1915, vol. iv, p. 794.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting, held October 4, 1915

The President, DR. JOHN H. GIBBON, in the Chair

FRACTURE OF THE OS CALCIS

DR. NATHANIEL GINSBURG related the details of four cases of fracture of the os calcis. The first two of these were observed and treated by him through the courtesy of Dr. Edward Martin. Their histories are as follows:

CASE I.—Case No. 10468. M. I., male, was admitted to the Mt. Sinai Hospital on April 4, 1915, and discharged on May 20, 1915. He had jumped out of a second-story window to escape from a fire, and landed on the heel bones of both feet. He was immediately brought to the hospital, unable to stand, with severe pain, swelling, and discoloration of the entire posterior portion of the foot and lower leg. X-ray showed present fracture of both ossa calcis. The patient remained in the hospital about six weeks and was finally discharged able to go about on a cane and crutch. He died six weeks ago of heart disease.

CASE II.—Case No. 10690. A. M., male, was admitted to Mt. Sinai Hospital on April 18, 1915, and discharged May 27, 1915. He fell from a step-ladder, alighting on the heel-bone of the right foot, and sustained a fracture of the os calcis. He now walks with a cane and has pain on the outer side of the foot below the external malleolus.

CASE III.—Female, aged thirty-five years, was admitted to Dr. Ginsburg's service at the Jewish Hospital, June 22, 1915, having fallen through a skylight to the floor below, landing upon both feet. She sustained a fracture of the left os calcis and a transverse fracture of the internal and external malleoli of the left tibia and fibula without separation of the latter fragments. In addition she sustained a fracture of the external tuberosity of the right tibia, the line of fracture running into the knee-joint, and a fracture of the adjacent head of the fibula with some impaction. This type of fracture of the tibia in this region is of rare occurrence. The patient was put to bed with moderate extension by traction appa-

ratus on the right leg, not sufficient, however, to separate the fragments but merely to prevent contact of the knee-joint surfaces.

The displacement of the os calcis was regarded as one which could not be markedly improved by operation or by much manipulation, and the foot and leg were put at rest in a fracture box and an ice-bag was applied to the seat of fracture, and after much of the swelling had subsided a light plaster case was applied enclosing the foot and leg. The fracture of the os calcis was of the comminuted type, involving the anterior extremity of the bone with some cortical tearing of the posterior plantar portion.

CASE IV.—Male, admitted to Dr. Ginsburg's service at the Jewish Hospital June 24, 1915, and discharged August 8, 1915. This patient fell down a casement and was admitted to the hospital suffering from fractures of the left humeral anatomical neck and a T-fracture of the left radius at the wrist-joint. The latter fracture showed some impaction and was apparently accompanied by a fracture of the styloid process of the ulna.

Under ether anæsthesia abduction and extension of the humerus at right angles to the body was maintained by a plaster case enclosing the thorax and the arm. The extension was maintained in bed by a traction apparatus similar to that applied in treating a fracture of the femur. A radiographic examination showed little improvement in the position of the fragments, the head of the humerus being elevated and rotated outward and the lower fragment being drawn upward and inward into a high axillary position. The plaster case was removed, the arm dressed to the side of the chest wall with a high axillary pad and a weight extension from the elbow. Good union in good position resulted, the movements of the shoulder-joint being excellent. The impaction of the lower end of the radius was broken up and a light plaster case applied, succeeding a Bond splint which was primarily employed. There is now little anatomical deformity and practically normal function of the hand.

Dr. Ginsburg remarked in connection with these cases that fracture of the os calcis is regarded by Cotton as being the commonest injury (fracture) of the tarsus. Three types of this fracture are commonly observed: (1) one being a fracture of the bone at the osseous attachment of the Achilles tendon; (2) a second type is a simple fracture of the sustentaculum tali; (3) and a third type, one which he had had the opportunity to observe in a number of patients, is a comminuted fracture of the body of the bone due to a compression force sustained by falling or jumping from a height and landing on one or both heels. This latter type is the one observed with greatest frequency. The dis-

FRACTURE OF THE OS CALCIS

ability resulting from fracture of the os calcis, especially of the comminuted type, is unquestionably a very severe and lasting one; in many instances the bony contour of the foot being so seriously disturbed as to permanently disable the patient. In this type of fracture of the body of the os calcis the molecular disintegration takes place approximately near a vertical line just in front of or through the posterior articulation between the astragalus and the os calcis. The comminution of the bone may be severe enough to result in a few fragments or in almost total disintegration of the body of the bone in the region injured. The lines of fracture may have a stellate appearance running off in various directions. The displacement resulting from a comminuted fracture about the middle of the os calcis, or anterior to a vertical line drawn through the middle of this bone, is apparently the result of the dropping down of the inner border of the foot, owing to the lack of bony support at this point, and also due to some "diminution of the total depth of the bone," especially of its forward end (Cotton). Should the displacement of fragments resulting from a fracture result in an irregular contour of the plantar surface of the os calcis, a painful foot will result, simulating the condition found in exostoses of the os calcis from other causes.

A fracture of the contiguous dorso-inferior articular portion of the scaphoid bone may result, if the compression force sustained producing the fracture is partly borne by this bone.

The diagnosis of this fracture can be made in most cases by a history of the accident sustained, which is usually a fall or a jump from a height, the patient landing on the feet. Much swelling and some distortion of the normal outlines of the foot in this region promptly take place. The swelling is often so marked, and manipulation is accompanied by so much pain that it is hardly justifiable to attempt a diagnosis by examining for mobility or eliciting crepitus of the fragmented bone. The radiologic examination is the important one both for diagnostic and prognostic value.

The immediate and diffuse swelling, accompanied by much pain and tenderness, is so marked that little can be done except to put the foot at absolute rest in a fracture box with an ice-bag or sedative lotion applied to the part. From radiographic study of the injury it can be determined if improvement in the position of the fragments is possible by the employment of an anæsthetic. If, however, the bony outlines are fairly well preserved, union will take place with a resultant good position of the heel, but with some tendency toward dropping of the inner posterior aspect of the foot. If indicated, tenotomy of the Achilles tendon should be done early to assist in mobilizing the posterior

fragment in order to reestablish the morphological outline of the bone.

DR. JAMES K. YOUNG said that this fracture is more common than is usually supposed. It is apt to occur when a person falls from a height and lights on his feet. One might expect it to occur from lateral crushing, as when a horse rolls on a rider's foot. In such accidents, however, and in automobile collisions the astragalus is more apt to be the bone fractured. He had seen a number of these cases several weeks after the injury and suggested more thorough treatment at the time of the injury in order to avoid the subsequent flat-foot and deformity of the ankle. Under an anæsthetic reduction should be made promptly by reimpaction of the fragments, with the hands or with a mallet and sandbag, after the method of Cotton. After the reduction, one felt pad should be placed over the dorsum, one over the os calcis and tendo Achillis, and one under the plantar arch, and, with plantar flexion of the foot and flexion of the knee, the foot and leg to the upper third of the thigh should be placed in a plaster-of-Paris cast for two weeks, after which manipulation and other remedial measures should be used.

T-FRACTURE OF THE LOWER EXTREMITY OF THE RADIUS

DR. H. A. MCKNIGHT (by invitation) presented a man forty-six years of age, whom he had seen in Dr. Booth Miller's clinic at the Polyclinic Hospital. The man, August 18, 1915, fell eight feet from a ladder, landing on his side and left arm, and in falling jammed his left closed fist against an iron beam; on recovering from the effects of his fall he noticed soreness and slight swelling of his left wrist.

Six days later the reporter saw him; he still complained of soreness and pain on motion. Examination showed increase in the anteroposterior diameter of the wrist, although this thickening was an uncertain diagnostic sign, as he had broken the other arm twice before, so no comparison could be made. The styloid processes were in proper alignment, but wincing tenderness was elicited along the radial shaft and on extreme abduction over the ulnar styloid.

The X-ray revealed (Figs. 1 and 2) an impacted fracture of the lower end of the radius with two linear splits extending upward for about one and one-half inches and nearly parallel with each other, being separated by an interval of a quarter of an inch below and one-eighth above, thus converging from below upward, a fracture of the ulnar styloid and a slight posterior displacement of the distal radial fragment. The skiagram shows complete impaction of the radial fragments which to a casual observer would present no abnormality, but the lateral view

FIG. 1.



FIG. 2.

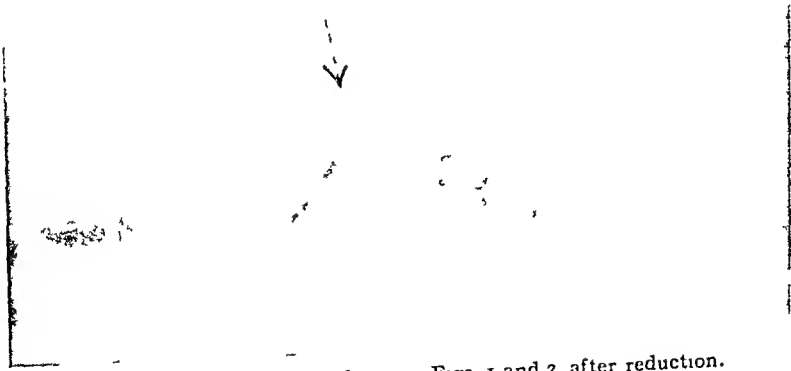


FIGS. 1 and 2.—Impacted fracture of lower end of radius with linear splitting.

FIG. 3.



FIG. 4.



FIGS. 3 and 4.—Fracture shown in Figs 1 and 2, after reduction.

FRACTURE OF RADIUS

(Fig. 2) shows the line of the radiocarpal articulation tilted backward instead of facing slightly forward as it does normally. The impacted fragments were separated under gas, and the arm splinted with a Bond and a posterior straight splint.

Skiagrams taken two days later (Figs. 3 and 4) show the arm after reduction; the transverse fracture is more distinctly shown, although the linear cracks are not so easily seen. The radiocarpal joint line is now normal and faces slightly forward instead of backward.

Dr. McKnight added that uncomplicated longitudinal fractures in this position are rare, only nine cases having been reported, and he had found none in which an impacted Colles's fracture was also present.

Bigelow in 1858 reported a stellate fracture of the lower end of the radius extending along the shaft, and Cotton in 1910 stated that, "So far as we know this fracture is the result of direct violence by crushing. It is rare, three specimens constitute the total of evidence." Since then Parrish, Bendell Wilhoit and Skillern have presented fractures of the radius, and Dr. Miller has seen one case caused by the direct violence of a window falling on the wrist.

The clinical diagnosis is difficult and has only been made heretofore by means of the X-ray, although the symptoms in the cases reported present marked similarity. There is usually a history of direct violence; clinical examination reveals slight swelling and tenderness along the line of the shaft, but no deformity. Treves reports a case in which he claims he felt a vertical linear ridge but was unable to make a definite diagnosis without the X-ray which showed a longitudinal fracture extending upward for about two inches.

In cases of direct violence due to direct force in the line of splitting the mechanism is simple. The scaphoid and semilunar are driven upward and outward by the upper end of the os magnum, causing a cross strain against the lower articulating end of the radius with resulting split. The further complication of a fractured ulnar styloid is not unusual, as 66 per cent. of fractures of the radius are complicated by this added fracture.

This case is of interest due to its rarity. The diagnosis in uncomplicated cases may be suspected clinically by analysis of the history plus a vertical linear area of wincing tenderness.

DR. JOHN B. ROBERTS showed two skiagraphs of a recent fracture of the lower end of the radius. They show a splitting off of a portion of the posterior lip of the articular surface very much in the direction described by John Rhea Barton. A good many medical men confuse the various fractures at the base of the radius with that described by

Colles of Dublin, which he considered to be an injury occurring about an inch and a half above the joint. It would be better to call a fracture at this point a break in the lower fifth of the shaft. The displacement is usually backward, but may be reversed so that the upper end of the lower fragment is directed forward. Almost all physicians give the name of Colles to all fractures of the lower end of the bone, whether they be at the point described by him, or the so-called classic fracture through the base of the radius with backward displacement. The latter was considered up to the time of Dupuytren a probable posterior dislocation of the carpus. Both the classic fracture and the true Colles's fracture have usually a backward displacement of the upper end of the lower fragment, but both of them may be reversed, the lower fragment being displaced backward at its lower end.

BONE TRANSPLANTATION

That no two fractures can be treated alike is a certainty. Each fracture is treated according to the individual status of that special case. Every Colles's fracture cannot be treated on a Bond splint, a Levis splint, a Palmer splint, a posterior splint, between two splints, or in a cast. Nor can every Pott's fracture be treated in a fracture box, on Dupuytren's splint, or in a cast. The treatment of each is adapted for the individual case. The same is true of the open treatment of fractures. Lane's plates, silver wire, catgut mesh, Parkhill's clamps, bone transplants, etc., each has its own advantages or disadvantages, and no one method can be used in every case.

In two of the cases cited below it was necessary to digress from the usual method of treatment. The principle of each seems sound.

DR. HUBLEY OWEN related two cases of fracture in which bone transplantation was employed in their treatment.

CASE I.—Miss S., aged twenty-six, fell downstairs on October 21, 1914, and sustained a dislocation of her left elbow, and a fracture of the lower third of the radius of the same arm. She was treated by her family physician and subsequently returned to her occupation, that of a stenographer, at the end of five weeks. Because of stiffness of her elbow and inability to properly supinate her left hand in order to typewrite, she was referred to reporter in January, 1915.

An X-ray was taken at that time, and showed an unreduced dislocation of the head of the radius and a fracture of the lower third of the radius, with vicious union. The lower fragment was displaced upward and inward, and was united to the upper fragment and to the ulna. Supination and pronation were impossible.

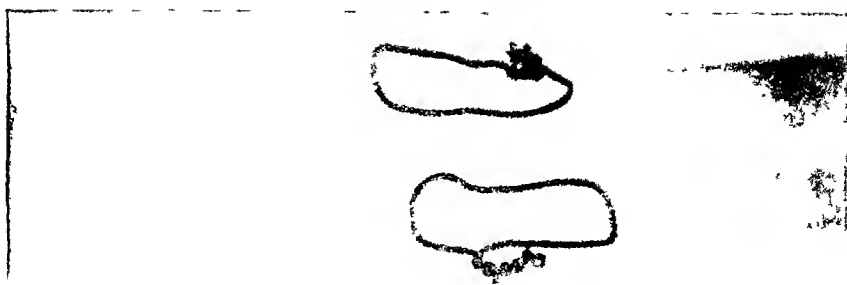


FIG. 5.—Bone transplant to fill defect in radius ; condition at time of operation.

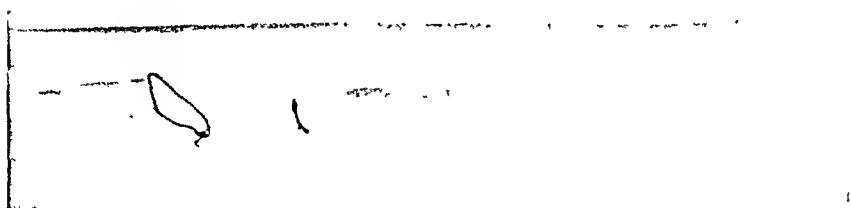


FIG. 6.—Final result of case shown in Fig 5.



FIG. 7 —Deformity after fracture of forearm.

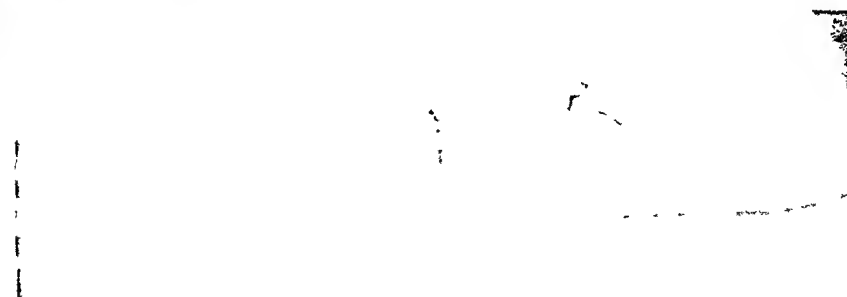


FIG. 8.—Fractured forearm, bone fragments dovetailed and secured by wire.



FIG. 10.—Fracture of patella.



FIG. 11.—Result of non-operative treatment.

BONE TRANSPLANTATION

On January 24, 1915, he removed the head of the radius, and attempted to correct the deformity of the broken radius. After he had separated the two fragments, and had also separated the lower fragment from the ulna, and straightened the wrist, he found that when the fragments of the radius were in alignment there was a gap of about an inch between the fragments. A transplant was then taken from the upper fragment, which was one-half the diameter of the bone. He was unable to transplant this into the lower fragment, so, as shown in the X-ray (Fig. 5), the transplant was merely laid alongside the two fragments and wired thereto. The second X-ray (Fig. 6) shows union of the two fragments.

The excision of the head of the radius gave her good motion in her elbow, and she now has good pronation and supination of her forearm.

There is some eversion of the hand, which can be corrected by the excision of a small part of the shaft of the ulna.

CASE II.—J. D., aged fifty-six, tripped and fell downstairs in July, 1915, and sustained a fracture of both bones of the left fore-

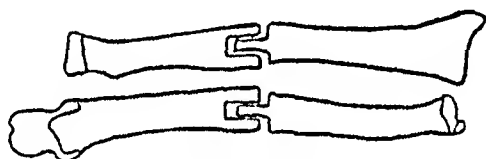


FIG. 9.—Diagram showing method of dovetailing bone fragments together.

arm. He was admitted to the Philadelphia Hospital three days after his injury, with the deformity as shown in the X-ray (Fig. 7). Two attempts were made to reduce the fracture with an anæsthetic. Both attempts were unsuccessful. Traction was then tried, but also failed.

He was operated upon August 10, 1915, and the attempt was made to hold the bones in alignment by dovetailing the ends of the fragments into each other. With a Gigli saw an oblong piece of bone was cut from the lower fragment, and, with the same implement, the upper fragment was cut so that it would fit into the groove of the lower fragment. He then supplemented this by silver wire, as shown in the X-ray (Fig. 8). The bones are uniting nicely.

Fig. 9 shows the manner in which the fragments were cut.

CASE III.—H. P., aged forty-six, fireman by occupation, fell in July, 1905, on his right knee, and sustained a fractured patella. He was treated at the Pennsylvania Hospital. He was not operated upon, but the fragments were held together by means of

adhesive plaster. At the present time he has fibrous union (Fig. 11) but has absolutely good function of his knee.

In November, 1913, while working at a fire, he fell and sustained a fracture of the left patella. He was operated upon at the Jefferson Hospital, and the patella was wired.

He again fell, September 26, 1914, broke the silver wire and refractured his patella. The case was in the service of Dr. J. Chalmers DaCosta, who advised against another operation.

X-ray plate (Fig. 10) shows the wide separation of the fragments of the patella.

By treatment with a brace, which was so constructed that he was given more motion in the knee-joint each week, he now has firm fibrous union (Fig. 11) between the fragments, has discarded the brace, and has perfectly good use of his knee.

THE RATIONAL TREATMENT OF VARICOSE LEG ULCERS

DR. PENN GASKILL SKILLERN, JR., read a paper with the above title, for which see page 176.

HÆMATOMA IN THE SHEATH OF THE RECTUS MUSCLE FROM RUPTURE OF THE DEEP EPIGASTRIC ARTERY

DR. SPEESE reported the case of a woman, aged sixty-two, who was admitted to the Presbyterian Hospital with the diagnosis of intestinal obstruction. The patient stated that ten hours before her admission, she developed a sudden and severe pain in the abdomen. The pain began in a swelling, situated below the umbilicus, which had been present for one year and which had been pronounced an umbilical hernia by her family physician. The patient was in moderate shock, the pulse rapid and weak, temperature a little below normal, she complained of nausea and had vomited several times. On examination a large mass was found below the umbilicus. This was regarded as a loop of intestine, not in an umbilical, but probably in an interstitial, form of hernia, and operation advised for an apparent strangulation. An incision was made over the tumor, and on opening the sheath of the rectus muscle, a considerable quantity of fresh and coagulated blood escaped, the slightest manipulation causing profuse hemorrhage. After packing the area from which the hemorrhage arose, and on careful exploration, it was found that the muscle was soft and pulpy, infiltrated with blood, and greatly resembled a strangulated intestine. Finally, the spurting epigastric vessel was disclosed and ligated. The muscle was so degenerated that six inches was removed. Palpation through the peritoneum did not reveal any abnormalities, so that the abdominal cavity was not opened. The sheath

HÆMATOMA IN SHEATH OF RECTUS MUSCLE

of the muscle was carefully sutured and overlapped, and the patient returned to the ward in good condition.

During her convalescence she was questioned more carefully concerning the development of the tumor. She was positive that it appeared suddenly about one year ago, and that there was no strain, blow, or other form of traumatism to account for its origin. On several occasions the mass enlarged slightly and became painful, but never had been so painful as during the last attack. The patient suffered from chronic nephritis and myocarditis, which complications prolonged her convalescence. The wound healed well, seemed solid and there was no tendency toward the formation of a hernia when the patient was seen last, three months after the operation.

Several years ago the author reported before the Academy a case of perirenal hæmatoma, and this case seems to belong to the same group. In perirenal hemorrhage, a definite cause may be demonstrated, such as tuberculosis, neoplasm, traumatism and hæmophilia. The spontaneous form is probably due to chronic nephritis, the only pathologic lesion which has been demonstrable. The same facts apply to the few cases on record in which spontaneous hemorrhage occurred in the rectus or other muscles. Hæmophilia has been noted in some of the cases, in others, as in the case reported, chronic nephritis has been present, and this, along with degenerative changes in the arterial system, may have acted as the etiologic factor in the production of the hemorrhage. It is noteworthy that massive hemorrhage into the perirenal or retroperitoneal space usually excites symptoms suggestive of intestinal obstruction, and that the same symptoms may be produced by hemorrhage into the sheath of the rectus or other muscles.

DR. FLOYD E. KEENE said that the case reported by Dr. Speese was similar to one which came under his observation on Dr. Clark's service in the University Hospital and appeared as a post-operative complication. Hysterectomy was performed in the morning and no untoward symptoms followed the operation until late in the evening when, following an attack of violent vomiting, there developed symptoms of internal hemorrhage. Operation was immediately done and an extraperitoneal cast of blood-clot was found, the source of hemorrhage being from the ruptured right deep epigastric vein, which was ligated. The peritoneal cavity was opened and found to be free from blood.

DR. A. P. C. ASHHURST said that he had seen one such case at the Episcopal Hospital in the service of Dr. George W. Norris, in the case of a youth, aged seventeen years, who was admitted to the medical ward January 16, 1912. His illness had begun on January 13, with pain in

the left chest, and on admission there was dulness and bronchial breathing at the base of the left lung. On January 18 the leucocyte count was 32,800. Dr. Ashhurst was asked to see him January 24. His temperature ran from 103° to 104° F., his pulse-rate was about 120, and his respirations were from 30 to 38. He was told that he had had a pneumonia at the base of the left lung, with pleural friction. There had been no abdominal symptoms except slight distention for the past several days. His bowels had been opened normally. Recently he was thought to have had pleurisy and perhaps pneumonia in the right lung. There had been no crisis. There were pneumococci in the sputum. The leucocytic count that day was 25,000.

The boy looked desperately sick; he was dyspnoëic, cyanosed, flushed, but clear in mentality. He could hardly speak, being very hoarse, with constant cough, and expectorating blood-stained mucopus. The left chest was strapped, and only dry, creaking râles could be heard. The right chest was dull high in the axilla, the breath sounds were well heard, and there were numerous very loud, moist and whistling râles. The abdomen was slightly distended all over; deep respiration was impossible without pain and coughing. In the right hypogastric region a poorly-defined mass was visible. This was very tender on sudden or deep pressure, and was surrounded by tympanitic areas on all sides. There was slight œdema of the overlying skin. There was no cutaneous hyperalgesia. The abdomen elsewhere was flaccid, but slightly distended. Peristaltic sounds were normal. No mass could be felt through the rectum. The bladder was empty.

Under local anæsthesia an incision was made over the swelling. On opening the anterior sheath of the rectus there was a discharge of liquid and clotted blood. The fibres of the rectus muscle were destroyed throughout the whole width of the muscle, and for a distance of about 2 inches longitudinally. The parietal peritoneum was opened, disclosing normal contents. The peritoneum was closed and the cavity in the rectus muscle drained with gauze.

The clots removed from the rectus muscle were examined by Dr. C. Y. White, Director of the Pathological Laboratories of the Episcopal Hospital; muscle fibres were still recognizable in the clot. Cultures of the clotted blood showed "a long chain strepto-diplococcus, not the pneumococcus."

The patient died three days later, January 27, 1912. Autopsy showed no peritonitis, but pneumonia and acute parenchymatous nephritis.

This case may well be classed as one of "spontaneous hæmatoma"

FOREIGN BODIES IN THE SMALL INTESTINE

of the rectus muscle, presumably due to metastatic infection by hæmolytic streptococci. He objected to the use of the term "rupture" unless there is evidence of injury.

FOREIGN BODIES IN THE SMALL INTESTINE

DR. GEORGE G. ROSS reported the case of a woman, aged thirty-five years, who was admitted to the Germantown Hospital, March 2, 1915, with a history of pain in the right lower abdomen. This had been marked during the last six months and was associated with soreness. Occasionally the pains were colicky. The pain was increased by stooping or turning in bed, and by walking. Painful and frequent urination; urine was cloudy at times; there was no leucorrhœa. Her appetite was good and her bowels regular. There were no gastro-intestinal symptoms; the heart and lungs were negative.

The abdomen was flat, no masses to be felt. Pressure in the right hypochondriac region caused pain in the right iliac fossa. There was marked tenderness over the entire right lower abdomen, especially pronounced over McBurney's point and just above the symphysis. Vaginal examination showed a movable uterus, with some retroversion and prolapse. There was a distinct tender mass to the right of the uterus.

The following information was obtained after the operation and this fact accounts for the incorrect diagnosis of tubo-ovarian abscess. She had been an inmate of the State Hospital for the Insane, to the authorities of which we are indebted for the following facts: Their diagnosis was constitutional psychopathy. She had attempted abortion in all four pregnancies. During the last pregnancy, three years ago, she had made almost constant attempts to empty the uterus. Among the methods employed were three boxes of Hooper's pills; gin and celery seed of which she took three quarts; and fifty cents' worth of Epsom salts taken in one day. On the advice of a clairvoyant she took a cupful of hot claret at the same time, soaking her feet in hot water containing a pint of chopped onions. She developed suicidal tendencies, one of her methods being the swallowing of pins, twisted bunches of hairpins, safety-pins, etc. After two years of treatment she recovered her mental balance and was discharged.

Operation.—Right rectus incision. The terminal ileum was bent on itself and the sides of the bowel were adherent to each other and the apex of the mass was adherent to the bladder. The knuckle of bowel contained a foreign body which felt like calcareous plates. This portion of the bowel was resected and lateral needle and thread anastomosis was made. The tubes and ovaries were normal. The wound was

closed without drainage. The resected gut contained eighteen to twenty pieces of thin, blackened wire resembling Gem paper clips or curtain hangers. One clip had perforated the wall of the bowel and projected into the peritoneal cavity.

DR. ADDINELL HEWSON said that he had found in the dissecting room of the Polyclinic a cadaver in which two steel needles had been forced by the patient between the occiput and the spinal column through the foramen magnum into the medulla and which were stuck against the ventral margins of the foramen magnum. In addition the patient had two needles of the same character in the nasal cartilage in front of the nasal bones. Her stomach was of enormous size. The needles had been in the spinal cord apparently for a long time because they were rusted. The woman was an insane patient and was from the same hospital from which Dr. Ross's patient came.

TORSION OF THE OMENTUM

DR. GEORGE G. ROSS reported the following case: A woman, forty years of age, was admitted to the German Hospital, August 13, 1915. Her chief complaint was pain in the lower right abdomen. Her trouble began five days prior to admission with pain in the upper abdomen, soon becoming general. Two days later the pain had localized in the lower right quadrant. There were 6200 leucocytes, a temperature of 100° and a pulse of 108. There were no chills. Appetite, bowels, heart, lungs, and kidneys were normal. This was her first illness. Family history was negative. Husband and four children well.

Examination was negative with the exception of a point of marked tenderness at McBurney's point. An ill-defined mass could be made out in the lower right quadrant. A diagnosis of acute appendicitis with abscess was made.

Operation.—The appendix was found acutely inflamed and covered with lymph. The omentum was found twisted on its long axis for about eight inches, there being three complete twists. It was dark purplish-red, congested, but not gangrenous. The appendix and omentum were removed as was an epiploic appendix which had become adherent to the mesentery of the ileum. The recovery was uninterrupted.

GALL-STONE ILEUS

DR. JOHN H. JOPSON reported the case of a woman, aged fifty-eight years, who had suffered for a long time with what was termed indigestion. She had been sick a week before admission to the hospital. The onset was sudden, marked by pain and diarrhœa, and following

GALL-STONE ILEUS

this no movement of the bowels could be obtained for six days. For the purpose of relieving the obstruction she had been given enormous doses of cathartics, including citrate of magnesia, blue mass, castor oil, calomel and rhubarb, as well as high compound enemata and opium. Vomiting was frequent and had been fecal for more than 24 hours before admission to the hospital. She was in fair condition; pulse and temperature not materially altered, abdomen flaccid, no areas of tenderness. No tumor could be felt and the rectum was empty. The stomach when washed out was found to be full of fecal matter. As soon as the abdomen was opened, the obstruction was located in a loop of the ileum, lying down in the pelvis. It was recognized to be a gall-stone and was removed by linear incision of the bowel. The opening was closed in the usual manner by two layers of sutures. The stone measured three inches in length by three-quarters of an inch in width, was smooth, oval, of an olive color and weighed 25 grammes. The bowel contracted very much at the point of suturing, evidently from muscular spasm. There were numerous adhesions in the hepatic region and no attempt was made to explore further in this direction. The first examination of the urine had been reported negative, but a second examination two days after operation revealed the presence of sugar, and in subsequent examinations as high as 3 and 4 per cent. was present; also acetone and diacetic acid. The patient's condition was poor after operation and there was marked cardiac weakness and paresis of the bowel, which responded to the exhibition of eserine, after pituitrin had been given without result. Probably as a result of an old diabetes, there was absolute failure of the wound to heal, although convalescence for the first week was almost afebrile. The wound opened up throughout its entire length and a loop of bowel protruded and the granulating process was exceedingly sluggish. At the same time, the patient's physical and mental condition were very bad. At the end of six weeks, as a result of diet and general medication, the acetone and diacetic acid had disappeared from the urine and also the sugar. The patient later developed a phlebitis, first in the left and later in the right leg, with occasional chills and rises of temperature, and succumbed rather suddenly seventy-eight days after operation to what was apparently a pulmonary embolus.

The history of this case as regards the gall-stone ileus is very typical of obstructions of this nature. The long duration of the obstruction before it became alarming to her medical attendants, is explained by the fact that these obstructions are seldom complete in the early stages, and there is an absence of strangulation of the bowel, while spasm

of the muscle fibres of the intestine is, according to Duplay and Reclus, responsible for most of the obstructive symptoms. The characteristic symptoms, according to Barnard, are the sudden onset, the absence of pain and collapse until late in the attack, the incomplete obstruction and the absence of tenderness and distention of the abdomen. Vomiting is a prominent symptom, being severe and continuous, while jaundice and true biliary colic are generally absent in the case of large stones. The mortality is high. The development of a septic phlebitis was undoubtedly responsible for the lethal termination of the case seventy-eight days after operation, and this phlebitis was probably dependent upon the toxæmia due to prolonged obstruction, the diabetic condition, and the delayed wound healing.

DR. ALFRED C. WOOD said that he had had the opportunity of operating on three cases of gall-stone ileus. The first case was that of a woman about fifty-eight years of age, with no previous history of indigestion or other illness, with the exception that at eight months prior to admission to the hospital she had an attack of pain which was thought to be due to pleurisy. During the three months prior to coming into the hospital she had attacks of constipation alternating with diarrhoea. At the operation a gall-stone was found in the ileum about 6 inches from the cæcum. As this stone was faceted, other stones were looked for, and a second stone discovered in the act of passing from the gall-bladder to the duodenum.

In the second case the diagnosis was made on account of the history of an attack some months before, that strongly suggested a gall-stone attack. The stone was found in approximately the same situation as in the preceding.

In the third case, the stone was of larger size and had been arrested at about a foot from the valve. A very careful study of the patient's history will sometimes enable one to suspect the cause of the obstruction in these cases.

MULTIPLE CARTILAGINOUS EXOSTOSES

DR. ASTLEY P. C. ASHHURST read a paper with the above title, for which see page 167.

DR. GWILYM G. DAVIS said that not infrequently these cases of multiple exostoses are seen in early adult life and in youth, and he did not think there is much doubt but that evidence of them exists in infancy. It is well to bear this in mind; otherwise the disease will be considered a new and active one, whereas it is a congenital trouble and of old standing. In some cases, in which only one or two exostoses are seen,

SURGICAL TUBERCULOSIS

if the X-ray were applied other parts would be found to be involved. This would account for some of the single exostoses supposed to be started by trauma.

DR. JOHN H. GIBBON asked Dr. Ashhurst whether syphilis plays any part in this disease of multiple exostoses. That was one of the causes assigned to the condition in a very marked case in his hospital service last year in which practically every bone in the man's body was involved. That man had had syphilis, but it is quite possible that he had the disease before he developed syphilis.

DR. ASHHURST, in closing, stated that the evidence is against syphilis being an etiological factor.

CHROME ULCERS IN LEATHER WORKERS

DR. J. CHALMERS DACOSTA read a paper with the above title, for which see page 155.

Stated Meeting, held November 1, 1915

The President, DR. JOHN H. GIBBON, in the Chair

SURGICAL TUBERCULOSIS TREATED BY THE ROLLIER SUNSHINE METHOD

DR. A. BRUCE GILL presented four children who had been treated for surgical tuberculosis by the Rollier sunshine method. These children have been exposed to the sunshine in Philadelphia and at Longport, which is on the seashore below Atlantic City.

The first case is that of a child who had osteomyelitis of the femur, fibula, and bones of the foot of the right lower extremity, with numerous sinuses discharging. The child was immediately put upon the sunshine treatment. At the end of four months the sinuses are all practically healed. We not only expose the affected part, but the whole body for a short time each day, so that the skin will not blister.

The second case was one of tuberculosis of the hip-joint; winter before last the child was extremely ill. The skin and soft tissues had melted away and exposed the neck of the femur, the great trochanter and three or four inches of the shaft. There was high temperature. In February of last year treatment was begun, at which time the child weighed 41 pounds. The first of June it was sent to the seashore and there the weight came up to 48 pounds. All through last winter the child was exposed to the sunshine whenever there was any and by the end of this summer the weight came up to 61 pounds. The child is now

quite well and is going to school for part of the day. Her wound is healed.

The third case is one of Pott's disease. A year ago an Albee's transplant was put in the spine. There was pus present at the time of the operation and the wound did not heal. Three or four weeks after operation there were signs of pulmonary tuberculosis. There were râles, cough and temperature. The child was put into the sunshine and after several months' time the sinuses healed up, after a small part of the transplant had come away.

A fourth child has a tuberculous hip-joint and is still kept in bed. At first the affected part itself is exposed and gradually the entire body.

It is worth while knowing that this treatment can be carried out in this climate. It is valuable in both tuberculosis and infected wounds.

DR. WILLIAM J. TAYLOR said that he was personally very much in favor of this method and had been advising it for some little time. In a tuberculous hip-joint where there was a sinus discharging for many months, under this form of treatment the wound has healed and the general benefit to the patient has been very great. At the Orthopædic Hospital the children are put out on the roof and kept exposed to the sun all day. The benefits are really very great.

IMPRESSIONS OF THE SURGERY OF THE EUROPEAN WAR

DR. EDMUND B. PIPER (by invitation) read a paper with this title, for which see page 208.

DR. CHARLES McDONALD and DR. JOHN F. McCLOSKEY also gave some personal reminiscences of recent experiences with war surgery in Europe.

DR. RALPH BROMER (of Louisville, Ky.) stated that he served as House Surgeon of the American Ambulance during the months of September and October, 1914. The mortality rate was high owing to the fact that during the retreat from Belgium the ambulance corps of the French and British armies were practically out of commission. Some of the wounded were from six to nine days without treatment. In eighteen deaths occurring on his service four were from tetanus and two from gangrene of the lung. He did not remember the exact number of amputations for gas infection. The cases too sick for operative interference were treated by administering oxygen under the skin in the good tissue around the wound. Quite a number of deaths also occurred because of secondary hemorrhage, this at times being quite sudden in its appearance. One man with a wound of the superior maxilla died quite suddenly on the fourteenth day from severe secondary hemorrhage. The point of hemorrhage could not be found at autopsy.

STRAUS'S METHOD OF FIXING FRACTURES

STRAUS'S METHOD OF FIXING FRACTURES

DR. JOHN B. ROBERTS said that surgeons often wished for some way of fixing fractures with something less troublesome than steel or metal bodies. He called attention to a recent paper by Dr. Straus, of Chicago. Straus makes a mattress of catgut to support the line of fracture and puts a plaster-of-Paris bandage outside. It occurred to Dr. Roberts to take a piece of fascia of the subject, coapt the bone, and place the fascia which later would become absorbed. To make the part a little more rigid a drill pointed nail could be used. This method ought to be better than putting in metal flaps. His idea was to modify Straus's original plan by using a piece of fascia from the thigh of the subject. Dr. Roberts further discussed the subject in a paper, for which see page 182.

BOOK REVIEWS

OPERATIVE GYNÆCOLOGY. By HARRY STURGEON CROSSEN, M.D., Associate in Gynæcology, Washington University Medical School. Six hundred and seventy pages with seven hundred and seventy illustrations. St. Louis, Missouri: C. V. Mosby Company, 1915.

THE author of this book writes with a positive pen dipped in a wide experience and a strong personality. He leaves no one in doubt as to his position upon mooted questions.

To quote briefly from the preface he says, "The time is ripe for a systematic presentation of the various operative procedures available for the treatment of each gynæcologic lesion. Gynæcologic surgery is entering a new stage of development. The past may be designated the period of invention of methods. To such an extent has this been carried that for the treatment of uterine displacement alone more than one hundred operative procedures have been devised. The new stage of development may be designated the period of adaptation of operative methods to the exact pathological conditions present in the individual patient."

About one hundred pages are devoted to the subject of retrodisplacement of the uterus, describing in detail the technic of "methods which have been so far perfected as to be considered of practical use to-day."

The treatment of prolapse of the uterus and bladder is classified under the same two great headings used in considering retrodisplacement, namely, (a) patients past the menopause; (b) patients before the menopause. The classification is further continued according to the pathology of the individual case.

It is worthy of note in these days of increased and increasing use of absorbable suture material that Crossen states, in connection with tracheloplastic operations, "silk-worm gut is the suture material of preference, except when the pelvic floor is repaired at the same time."

The chapter upon extra-uterine pregnancy is thorough, the author being in accord with that increasing group of gynæcologists who believe in a more conservative treatment "even in the so-called tragic cases."

The chapter upon carcinoma of the uterus is excellent, it includes a thorough, accurate description of Percy's contribution to this subject. We wish the author had omitted the reference to Heitzman's sulphate

BOOK REVIEWS

of copper test for carcinoma of the cervix, since this experiment is known to be unscientific and unreliable.

In considering the injuries of the pelvic floor Crossen advisedly prefers the term relaxation rather than laceration as used in the Bellevue nomenclature.

In a work professing to set forth those operative methods "so far perfected as to be of considerable practical use to-day," it is to be regretted that he does not notice the remarkable work of Ristine, of Knoxville, Tennessee, in connection with complete tear of the pelvic floor.

After-treatment in abdominal section and vaginal operation is carefully treated, in an excellent manner. The volume is concluded by a chapter concerning medicolegal points.

We recommend the volume to the general practitioner who seeks accurate information in a department of science, and to the specialist who wants a reliable volume of ready reference on modern operative procedure.

FREDERICK C. HOLDEN.

THE RÖNTGEN DIAGNOSIS OF SURGICAL LESIONS OF THE GASTRO-INTESTINAL TRACT. By ARIAL W. GEORGE, M.D., Assistant Professor of the Department of Röntgenology, Tufts' College Medical School, and RALPH D. LEONARD, M.D., Assistant in the Röntgen Department of the Boston City Hospital. Boston, 1915: The Colonial Medical Press.

This attractive volume is a quarto of two hundred and eighty pages and contains, besides reproductions of three hundred and forty-three Röntgen plates, eighteen artist's drawings and seven three-color illustrations. The authors say that the purpose of the work is to demonstrate what one Röntgen Clinic has accomplished toward establishing a method for exact diagnosis in the common surgical lesions of the gastro-intestinal tract. The cases upon which the study is based are all taken from the private clinic of the authors, with a trifling exception. The diagnosis in each case is further checked up by operation, autopsy or unmistakable clinical course.

This is practically an atlas of the gastro-intestinal tract as revealed by the Röntgen ray. The plates given are uniformly clear and convincing, although it is true that their proper reading or interpretation can only be done by one who has had considerable practical experience in such work.

BOOK REVIEWS

The cases are divided into nine sections: (1) Normal stomach; (2) gastric ulcer; (3) gastric new-growth; (4) duodenum; (5) gall-bladder; (6) small intestine; (7) appendix; (8) large intestine; (9) diverticulitis. Each section is prefaced by a brief consideration of the routine and technic of the Röntgen examination of that particular segment of the digestive tract. No matters pertaining to clinical evidence or diagnosis are admitted.

The volume as a whole is of great value in presenting as it does, clearly and faithfully, so large a collection of plates for study and comparison.

LEWIS S. PILCHER.

To Contributors and Subscribers:

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N. Y.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS of SURGERY

227-231 S. 6th Street

Philadelphia, Penna.

ANNALS *of* SURGERY

VOL. LXIII

MARCH, 1916

No. 3

THE CLASSIFICATION OF TUMORS

BY C. MANSELL MOULLIN, M.D. (OXON.)

OF LONDON

CONSULTING SURGEON TO THE LONDON HOSPITAL

THE great variety of tumors makes their classification difficult. No method hitherto suggested can be said to meet all the requirements. The division into simple and malignant, for instance, is convenient, for it furnishes a good working rule in practice, where an opinion to be of any value must be dogmatic, but as a classification it cannot be upheld. There is no such thing as a separate class of malignant growths. No hard and fast line can be drawn between them and other growths. Malignancy is an occasional feature of all classes of tumors, even of those that enjoy the best reputation; and it is not uncommon for a tumor, to all appearance non-malignant, to increase slowly in size for years, or even to remain stationary for a time, and then suddenly to change its character and destroy life in the course of a few months. Nor is there any fixed standard of malignancy. It varies in degree even among tumors that appear to be alike. Malignancy is a clinical feature, and clinical features do not provide a good basis for the classification of pathological growths.

Classification by structure promises better. Broad general lines can be drawn and many groups of tumors can be separated from the rest. In other instances, however, the structural details are so varied and complex that general agreement seems to be almost impossible. Classification by origin is better still. Unhappily, however, the basis usually chosen, the three germinal layers of the embryo, is not sufficiently exact. The layers are not all of equal value, and they do not remain distinct from each other, so that it is often impossible to be certain to which of them a particular growth should be assigned.

Tumors, using the word in its ordinary acceptance, are divided into two classes: One is due to the reproductive power that all tissues naturally possess being suddenly roused into action. The other to changes that should take place in the course of development not being

efficiently carried out. It is not impossible that there is one and the same cause underlying both of these.

I. TUMORS DUE TO THE REPRODUCTIVE POWER OF THE TISSUES

The power of reproducing their like, directly, without assistance from any other source, is the common property of all living things and of all their parts. It belongs to them as their birthright, in the same way as the power of growth, for reproduction is only growth beyond the individual; and it remains with them throughout their lives. The extent to which they make use of this power furnishes the most satisfactory basis for the classification of the tissues and of the tumors that grow from them.

The Division into Germ Cells and Somatic Cells.—In the most primitive forms of life, before there is any division of labor, every part of the organism can give birth to buds capable of growing into organisms like the parent. With the advance of organization different duties have to be assigned to different portions of the body, and because the existence of the race depends upon it, the first to be assigned in this way is the function of reproduction. At a very early period one group of cells is marked off for this special object and becomes the germ organ. Henceforth the whole reproductive power of the organism is centred in this. The cells that compose it are the only ones that give birth to buds capable of growing into perfect organisms like the parent.

The rest of the cells, known as somatic cells, have an entirely different duty. They have to carry out the different kinds of work upon which the life and well-being of the individual depend. They are no longer concerned with reproduction. So long as conditions are normal they are never called upon for this, and as they become specialized for other kinds of work, they gradually lose the capacity of carrying it out. The progressive deterioration of their reproductive power is shown as well in the evolution of the race as in the development of the individual. In the earliest days the somatic cells, like the germ cells, can give birth to buds capable of growing into perfect organisms. In the ova of some of the echinodermata, for example, the somatic cells and the germ cells can be displaced artificially, and each will then undertake the functions of the other. Later the somatic cells are only able to reproduce portions of the body, such as limbs, as in the crustacea, and simple organs. Later still, this is beyond them. The only structures they can reproduce, even in embryonic life, when their powers are so much more active, are tissues like their own, and as specialization advances even this fails them.

THE CLASSIFICATION OF TUMORS

Their power becomes so limited that only the simplest kinds of tissue can be reproduced at all.

This division into germ and somatic cells, founded upon the use they make of their reproductive power, is the primary division of the organism. On it is based the classification of the tissues and of the tumors that grow from them. One class of tumors grows from tissues in which the reproductive power has been raised to the greatest perfection. The other from tissues which originally possessed this power in equal measure, but which never make use of it, so long as conditions remain normal, and therefore gradually lose the capacity of using it.

The characteristic feature of all these tumors, that which distinguishes them from others and from the structures among which they lie, is their independence. They are not able to support themselves, it is true, but their life is distinct from the life of the structure from which they grow. If transplanted to another host, so that they can get supplies equally well, they continue to grow and thrive long after the original parent is dead. They live upon the parent, like a parasite upon its host, drawing all they want from it, doing nothing for it in return, and in certain instances draining it of all its strength until it dies of starvation. These tumors are the offspring of the tissues from which they grow, and belong, not to the same generation, but to the next.

The first beginning of these tumors is in the form of a bud growing out from tissues that are apparently normal. They may develop into organisms almost as perfect as the one from which they grew; or into structures composed of well-formed tissues; or into mere masses of cells heaped together without order or arrangement. Which of these forms the tumor takes (or, in other words, the degree of organization of which the tumor bud is capable) depends upon the stage in the life history of the race that the parent cells had reached at the moment that the bud began to grow. The individual is the epitome of the race. Each cell as it develops passes through all the stages through which its ancestors passed in the course of evolution, and any bud that is given off by the parent cell before it has reached its final form possesses the same powers that the corresponding ancestor possessed in days gone by. The bud that grows from the cells of the early embryo, like those that grow from the tissues of lowly organized forms of animal life, is able to reproduce the organism, more or less perfectly, while that which is given off late in adult life is limited to the production of a growth composed of simple tissues.

The structure of a tumor depends upon that of the parent stem.

It is never so perfect but there is always a general resemblance. The character of the tumor, whether it is malignant or not, depends upon the maturity of the parent cell at the moment the bud began to grow. These tumors may assume many different forms—a form that grows fast, or a form that grows slowly; a form that remains circumscribed and limited, or a form that retains its embryonic characteristics, spreads in all directions and invades other organs. If the parent cell when it gives off the bud is still in the actively growing embryonic stage, the bud will be embryonic too. If it has already reached adult age, the bud will increase in size with proportionate slowness, and push surrounding structures to one side instead of invading them. Every organ and every tissue has its own kind of tumor which resembles it in structure more or less, but which according to the degree of maturity attained by the parent cell, at the moment of its birth, may be benign or malignant, or benign first and malignant afterward, or so evenly balanced between the two that it is impossible to say whether it is one or the other. There is no separate class of malignant tumors; rapidly growing malignant forms occur in all classes.

(a) *Tumors of the Germ Organ and Its Derivatives.*—Nearly all of these spring from the germ organ or the ovary. They rarely grow from the testis, at any rate after the sperm cells are developed, probably because of the high degree of specialization they have attained. It is not possible to arrange these tumors in classes. They form a series almost without a break, ranging from included foetus at one end to ovarian adenomata, mere heaped-up masses of epithelial cells, at the other.

Included foetus: In the earliest days of existence the reproductive power of the germ cells is only paralleled by that of the most primitive organisms. Like these the germ cells can give off buds capable of growing into organisms almost as elaborate as the parent one. Tumors of this kind are known as included foetus. They grow from the germ cells before the generative organs are differentiated and occur therefore in both sexes. As a rule, they are met with in the genital area. They may, however, occur in distant parts of the body and then they are due either to the accidental displacement of some of the cells of the germ organ in the course of development, or to the fact that some of the somatic cells have been stimulated into excessive action before their latent reproductive power has lost any of its primitive vigor.

Internal teratomata: As the power of direct reproduction diminishes in the course of racial evolution, leaving traces of what it once could

THE CLASSIFICATION OF TUMORS

do here and there (as where, for instance, generations of certain insects are produced for a time asexually), so too it diminishes in the course of the evolution of the individual. Buds given off by the germ cells in the earliest moments of individual existence grow into structures almost as perfect as the parent. Those formed later, known as internal teratomata, are far less complete. They may be made up of organs presenting a general resemblance to those of the parent, but their structure is imperfect; there is no order in their arrangement, and they are quite unlike anything else in shape and outline.

Ovarian dermoids and ovarian adenomata: No hard and fast line can be drawn between internal teratomata and these, which undoubtedly originate from the reproductive power of unfertilized ova, roused into action by some stimulus. There is one long unbroken series of tumors, arising by direct reproduction, first from the germ organ and then from the ovary, ranging from the most complex, produced in the earliest moments of individual existence, to the simplest, which often do not make their appearance until old age.

(b) *Tumors that Grow from Somatic Cells.*—There is no difference between germ and somatic cells at first. Their power of direct reproduction is practically equal. In certain circumstances one group can be made to replace the other and undertake all its duties, and it is possible that some of the complex tumors met with in distant parts of the body, which are usually said to arise from displaced cells of the primitive germ organ, are really due to the still intact reproductive power of somatic cells. The direct reproductive power of the somatic cells, however, very soon falls away as they devote themselves to other duties, and with the possible exception of those I have just mentioned, no tumor bud that grows from somatic cells ever attains a high standard of organization. They may be formed of tissues, more or less well developed, heaped together with a certain amount of order or arrangement, but they are never made up of structures such as organs.

The classification of the tumors that grow from the somatic cells depends upon the classification that is adopted for the tissues themselves. Every tissue has its own kind of tumor, just as it has its own kind of structure. However much one tumor resembles others in general arrangement, it differs from them just as the parent organ differs from the rest. Under the term adenoma, for example, are included all tumors built up on the lines of glandular tissue; but those that grow from the parotid gland are as different from those that grow from the mammary gland as one organ is from the other. So it is with fibromata, lipomata, epitheliomata, and many others. They have

certain general features in common, like the cells from which they grow; but those that grow in one part of the body behave quite differently from those that grow in another, even though we may not be able to detect any difference in their structure; and tumors that grow from such organs as the thyroid and prostate are so different from all others, that they can scarcely be brought into the same scheme of classification. Every organ and every tissue has its own kind of tumor.

2. TUMORS DUE TO ERRORS OF DEVELOPMENT

These differ from the tumors caused by the sudden awakening of the reproductive power of the tissues in that they do not possess an independent existence, and that they belong to the same generation as the structure from which they grow, and not to the next.

Irregularities of development may lead to tumors of various kinds, such as inclusion dermoids, but the most important are those that result from its premature arrest.

Development implies not only the progressive advance of tissues that are of use, but also the recession and disappearance of those that have ceased to be of use. It involves not only evolutionary changes, but involutionary ones too. Arrest of either of these may lead to the formation of tumors.

The ordinary meningocele is an instance of the former. The medullary groove fails to close at the proper time, leaving an unprotected place on what will become the outer wall of the organism. As size increases and the tissue pressure with it, this weak place is forced to yield, and the body covering is gradually pushed out farther and farther until at last it forms a cystic tumor the covering of which is the everted floor of the medullary groove.

Instances of the latter are more common. There are many organs present in early life, of which no trace is to be found in later years, and many more of which some small portion only persists because it has been possible to adapt it to other purposes. Disappearance of structures that are no longer of use is part of the normal development of the body. If development is arrested these structures persist. Sometimes they remain stationary and do no harm; but they may continue to increase in size in proportion as the body increases, and to work after a fashion, and then they may grow into the most formidable tumors. Cysts developed from the remains of the hyolingual duct or the Wolffian or Mullerian ducts may not be serious, but those developed in the coccygeal region, in connection with the postanal gut, often lead to the gravest consequences.

ACUTE DILATATION OF THE STOMACH COMPLICATING OPERATIONS ON THE EXTREMITIES

BY ISIDORE COHN, M.D.

OF NEW ORLEANS

ASSISTANT PROFESSOR OF MINOR SURGERY AND INSTRUCTOR IN CLINICAL SURGERY, TULANE UNIVERSITY

SINCE the description of the clinical syndrome, now recognized under the name of acute dilatation of the stomach, by Hilton Fagge in 1873 (*Guy's Hospital Reports*), cases have been recognized and theories have been advanced as to the etiologic factors and the sequence of events in the abdominal cavity.

As one reviews the literature several facts become apparent at once: (1) The condition arises in the course of the most varied clinical entities. (2) It may occur at any age and without any previous evidence of disease. (3) Either the pathologic picture is not constant or two or more pathologic conditions produce identical clinical symptoms. (4) The evidence as presented in the literature is confusing and contradictory.

The most complete American reviews have been made by Conner (1907), who was able to collect 102 cases, of which number 5 *followed operations* on the extremities; and Laffer (1908), who states that "it occurred eleven times after a variety of operations on the extremities." He did not tabulate the cases, nor give the operators' names. This omission on the part of the author was probably due to the apparent unimportance of this phase of the question.

Incidentally, from the recent tabulation of cases by Borchgrevink, it would appear that Laffer's case, following drainage of empyema of the antrum of Highmore, is the first recorded *American* case following an operation on the head and extremities. No subsequent case has been reported so far as I know.

It is well to insert here the previous tabulations of cases by Thomson, Borchgrevink and others:

H. Campbell Thomson, in 1902 ("Acute Dilatation of the Stomach"), collected 44 cases. Of these 6 followed operations on the extremities. A summary of these cases follows:

ALBRECHT (1899): Operation on elbow. Female, aged thirty years. Onset 5 days after operation. Died 11 days after operation. Postmortem: Stomach greatly enlarged.

Box and WALLACE (1901): Lacerated wound on the knee-joint. Arthrec-

tomy, amputation. Death. "Dilatation of stomach and duodenum, the dilatation of the latter extending to the place where the duodenum came in front of the lumbar spine."

GOODHART, J. F.: Excision of knee. Male, aged twenty-nine years. Death 75 hours after operation. Postmortem: Stomach dilated, nothing else abnormal except some œdema of the lungs.

HOOD, DONALD (1891): Abscess of lower jaw. Stomach, duodenum and first few inches of ileum dilated.

JESSOP, T. R. (*Lancet*, 1888): Excision of hip. Female, aged twenty-six years; died fourth day after operation. Postmortem: Dilatation of stomach and duodenum "which passed abruptly to a condition of extreme contraction 6 inches below the duodenum."

MORRIS, HENRY (*Transactions Path. Soc.*, London, vol: xxxiv): Male, aged thirty-seven years. Operation on foot. Onset one hour after operation. Death two days later. Postmortem: No notes.

Thomson does not cite *any personal cases which were associated with operations on the extremities.*

Borchgrevink records the following cases (1913):

BRAUN and SEIDEL: External urethrotomy.

P. BULL: Amputatio crures.

LAFFER (American): Drainage of antrum for empyema.

BAILLET: Exarticulation humeri.

It would seem that there are 10 recorded cases. If we exclude cases having to do with operation on the chest and perineum, we have 9 cases of which data are available in foreign and American literature.

Borchgrevink admits that his statistics must be incomplete so far as American cases are concerned. For that reason and because it has been my misfortune to have had this complication arise following an operation for osteomyelitis of the femur, I undertook to review the literature to tabulate the known cases and, if possible, to add such cases as might be obtained as a result of personal communication with about 125 American surgeons.

I sent out a list of questions of which the following is a copy:

How many cases of post-operative acute dilatation of the stomach have you had, which were not associated with abdominal operations?

Will you please state the nature of the operation?

If possible, please state sex. Age.

Time of onset

What have been the prominent symptoms?

Method of treatment. Results. Autopsy findings.

More than sixty answers were received as a result of this inquiry

ACUTE DILATATION OF THE STOMACH

and I have been able to collect four cases besides my own in which an operation was performed (DuBose, Corbett, Lilienthal, Pilcher) and two cases (DuBose and Rixford) in which the condition followed fracture and "severe trauma" of the lower extremity. From a personal communication of Dr. Frederic J. Cotton it would seem that symptoms of acute dilatation following fractures of the lower extremity and spine are not an uncommon happening in his experience. Quoting from his letter we find, "I have seen perhaps half a dozen such cases in fractures of the femur all of which recovered, and I know of one other such case which died under the picture of obstruction. I have seen a number of cases in which a similar abdominal picture was associated with fractures of the spine, without cord symptoms."

The rarity of the condition in the experience of American surgeons can best be appreciated by quoting from some of the letters which I have received:

DR. CHARLES F. PAINTER, of Boston, states, "I have never *seen* or *heard* of a case of acute dilatation of the stomach following any operation on the extremities."

DR. W. S. BEAR, of Baltimore, "I have had no cases of acute dilatation of the stomach following operation on the extremities."

DR. ALBERT FREIBERG, of Cincinnati, "Although operations upon the extremities predominate in my work and although I have been doing this work for twenty years I have no recollection of any case of this character nor do my records show any."

DR. J. C. BLOONGOON, in 1907, reported 6 cases of acute dilatation of the stomach, none of which were associated with operations on the extremities. In a personal communication he says, "I do not know of any case that I have had not associated with abdominal operations, except those mentioned in the reprint."

Dr. E. H. Bradford, of Boston, simply answers, "None," to the question, "How many cases of acute dilatation of the stomach have you had which were not associated with abdominal operations?" A like answer has been received from Drs. Matas, Kanavel, J. M. T. Finney, De Witt Stetten, Phemister, Leonard Freeman, H. M. Sherman, J. E. Thompson, A. P. C. Ashhurst, Joseph Rilus Eastman, Dean Lewis, Urban Maes, William Brickner, A. F. Jonas, W. W. Grant, Albert Goldspohn, H. G. Wetherill, Jno. E. Summers, H. G. Sloan, T. W. Huntingdon, J. N. Jackson, L. L. McArthur, J. L. Porter, Floyd McRea, J. F. Binnie, Louis Frank, J. Stewart Rodman, C. N. Dowd, J. Young Brown, J. T. Bottomley, Leo Buerger, L. M. McMurtry, C. E. Ruth, Charles Goodman, D. D. Eisendrath, Moschcowitz, Wm. L. Rodman, A. J. Ochsner, W. T. Westmoreland, J. F. Golden, A. E. Halsted, Emile G. Beck, Carl Beck, Duncan Eve, Willard Bartlett, W. A. Bryan.

From the Mayo Clinic at Rochester, I have received replies from Drs. W. J. Mayo, Henderson and Beckman. Dr. W. J. Mayo says, "I think that we have had one or two instances of this kind, but regret that we have thus far been unable to find them."

Dr. Henderson says the following: "I have never seen a *real* case of acute dilatation of the stomach after an operation on the extremities."

Dr. Beckman says, "We do not recall any cases of acute dilatation of the stomach following operation upon the extremities."

The above replies should be sufficient to convince one of the rarity of the complication, and yet a suggestion of Dr. Duncan Eves in regard to his own experience may aptly be stated here—"I have not had a single case of acute dilatation of the stomach from any cause, at least, if I have I have failed to recognize same and may have ascribed the death, as some of us will do, to some other cause."

I wish to add to the number of recorded cases my own with those of Drs. G. DuBose, J. F. Corbett, H. Lilienthal and L. S. Pilcher.

CASE I.—Case of Dr. F. G. DuBose, Selma, Ala. (personal communication). Patient was a male, aged twenty-four, on whom the doctor put a Lane plate for a fractured femur. The anæsthetic used was ether. Symptoms developed *seven* days after operation and the patient died in fourteen days. No autopsy could be obtained.

CASE II.—Case of Dr. J. F. Corbett (personal communication). The patient was a female, aged twenty-eight years, on whom the doctor did a "resection of the jaw." Symptoms developed twelve hours after operation. Recovery. The anæsthetic used was not stated.

CASE III.—Case of Dr. Howard Lilienthal (personal communication). Male, aged thirty-seven. Operation—resection of elbow. Ether was used; symptoms developed within 48 hours. Recovery.

CASE IV.—Case of Lewis S. Pilcher (personal communication). Female, aged seventy-one. Operation—amputation lower third of thigh for diabetic gangrene of foot. Anæsthetic, nitrous oxide and oxygen. Symptoms developed twelve hours after operation; relieved by repeated lavage. Death on fifth day from diabetic coma. Autopsy—stomach normal; chronic inflammatory changes in pancreas, liver and kidneys.

CASE V.—Case of author. M. H., white, female, aged nineteen years.

Past History.—Had the ordinary diseases of childhood; diphtheria and pneumonia when a child.

Present Illness.—About January 15, 1915, she noticed a small lump on the right side of her face. Dr. Love was called in and found a small pustule surrounded by a large area of redness. This was treated in a conservative manner by Dr. Love for four days,

ACUTE DILATATION OF THE STOMACH

but noticing a spread of the condition and believing it to be erysipelas, I was called in consultation.

On January 22, 1915, I saw her for the first time. The temperature then was 103° ; the right cheek was swollen, red and painful to the touch. There was a marked thickening of the skin, with little fluctuation. The pulse was very rapid. Patient excited. Under local anæsthesia two incisions were made. Only a small amount of pus and some blood discharged. In a few days the swelling had increased until the œdema had closed the eye; the temperature fluctuated between 100° and 105° . She complained of some chilly sensations; restlessness and irritability were marked; vomiting was a prominent symptom; the discharge of pus was rather free. After a few days the buccal mucosa ulcerated; however, on February 12 she was discharged. The wounds had healed and she was considered in fair shape.

She later complained of pains in her chest, back, thighs and ankles which Dr. Love considered probably of toxic origin. In the meantime she had developed a slight temperature which Dr. Love associated with endocarditis.

On March 19, 1915, I was again called in consultation because of a pain in the left thigh. Examination at that time showed the following: Temperature 103° ; pulse 120; left thigh larger than right, particularly at the middle third. Palpation revealed a definite hard mass arising from the shaft of the femur and continuous with it. Pressure over the femur caused pain. An X-ray was taken by Dr. Henriques, who interpreted the picture as acute periostitis. However, as I was convinced that the condition was due to pus within the medullary canal, I operated at Touro, March 22, 1915.

I found a large quantity of new bone surroundingg the shaft at the junction of the middle and upper thirds of the femur; the muscles of the neighborhood were already infected, in fact some of the muscle-tissue was apparently ready to slough off. When the medullary canal was opened a large quantity of free pus was found. Cultures were made and Dr. John Lanford reported a pure culture of staphylococcus aureus. A large opening was left in the medulla after apparently all of the necrotic bone and breaking down marrow had been removed. A large rubber drain was inserted down to the canal. No packing nor plug was inserted, as I believe that in removing the pack after several days you take along with the gauze the delicate young osteoblasts from the endosteum. Drainage being well established, nothing more seemed indicated. A body cast was applied including thigh and leg.

After the operation the pain disappeared, but the pulse and temperature did not drop. On March 29, the temperature dropped

to normal and remained at that level until April 11, 1915. In fact the temperature did not rise above 100 again until April 25. All the while there was a profuse discharge from the wound, and on May 3 a second radiograph confirmed the opinion that there had been an extension of the disease. We operated again. This time practically the entire medullary canal was laid open, and left open; in order to keep it open I left in a gauze pack. For two days following operation she vomited frequently, and since the pulse was already weak, I felt that fluids must be supplied. We, therefore, gave glucose 4 per cent. drips. During 72 hours, 14 pints of 4 per cent. glucose were given, after which a specimen of urine showed 1 per cent. sugar in the urine. However, on the previous day after 10 pints of 4 per cent. glucose, no sugar was found.

May 7, four and a half days after the operation, she again started vomiting, now only after nourishment—no vomiting at night. Urine shows no sugar.

May 9, six days after operation, nourishment by mouth discontinued. No vomiting.

May 10, nourished well; no vomiting.

During the night of May 11 she again began vomiting after taking fluids. The bowels had acted well every day.

From May 7 to May 12 the temperature was practically normal. On May 12 a new plaster cast was applied and the wound dressed. After returning to her room she began vomiting large quantities of dark-brown fluid. She was unable to retain anything.

On May 14 at 4 P.M., her temperature was 98.6°, pulse 90, respiration 28. At 7.30 P.M., the same day, her temperature was 101.8°; pulse 150; respiration 26.

The stomach tube was introduced and 52 ounces of green fluid was siphoned. The patient's appearance had entirely changed. She was cold and clammy; the face bore the expression of anxiety, the pulse was hardly perceptible at times. Hypodermoclysis was started as well as the free use of hypodermic stimulation (strychnine, morphine, digalen and caffeine, alternately). During the night she was delirious: she did not vomit during the rest of the night. A total of 1900 c.c. of saline solution was given from 10.15 P.M. to 7 A.M., during which time the pulse picked up in volume and the rate diminished until it was 112 at 7 A.M.

On May 15 there was no vomiting, the hypodermoclysis, however, was kept up. The urine at this time showed a trace of albumen, hyaline and granular casts, and red blood-cells.

May 16, vomiting. Stomach emptied and washed. At this time it was noticed that the abdomen was distended, particularly in the upper segments, and the greatest prominence was to the left of and below the umbilicus. When the stomach would be

ACUTE DILATATION OF THE STOMACH

emptied the distention would disappear as well as the prominence to the left of the umbilicus. The largest quantity that was siphoned off at any one time was *seven* pints. This contained blood and bile. During the three days, May 15 to 18, hypodermoclysis was kept up continuously, but in spite of all effort the stomach would fill up and the patient succumbed on March 18.

Autopsy (Dr. Lanford).—The peritoneal cavity was found free from fluid or any evidence of acute inflammatory processes; the omentum free but rather short; the stomach was enormously dilated and extended from the diaphragm into the pelvis. It was filled with fluid and gaseous material. The intestines were also somewhat distended. The lesser peritoneal cavity was negative. Appendix was negative.

The liver was smooth and of a dark brownish-red color. It was quite congested. The spleen was considerably larger than normal, of a dark brownish-red color, soft and pulpy in consistency. It was covered with a few organized adhesions. The pancreas and adrenals were negative. The kidneys were somewhat swollen and markedly congested. The cut surface showed evidence of increased pressure and was of a dark reddish-brown color, there being but little contrast between the two parts. It bled rather freely on sectioning.

The pelvic organs were negative.

Cases of acute dilatation of the stomach in association with operations on the extremities immediately invite attention to their etiologic factors. Why should a complication of an organ so far removed from the site of the operation arise? The situation seems still further to be complicated when we realize that the same train of symptoms arise in patients who have been previously healthy, in the course of disease such as pneumonia, typhoid and scarlet fever, after a severe trauma, which may or may not cause a fracture, after delivery as well as after intra-abdominal operations. Strange as it may seem, only a few cases have followed operations on the stomach itself. Borchgrevink (1913) was only able to find six cases where an operation had been done on the stomach itself. The above facts suggest certain questions: (1) Is there a common etiologic factor present in all cases—a disturbance of innervation, or is there a constant mechanical condition present? (2) If the constant etiologic factor is not a disturbance of innervation, how do the several distinct exciting causes produce the condition which in turn produces the symptoms of acute dilatation of the stomach? (3) Do we always have evidence of a mechanical factor at autopsy? (4) Are we dealing with several distinct entities which give rise to the same symptoms?

To answer these questions one had best turn to the literature to see what has been done to solve the problem. Here one meets with a series of contradictory statements, some based on (1) experimental

evidence, others on (2) suppositions, and (3) some on the finding at section of the abdomen during life or autopsy.

The autopsy findings in these cases have had only one *constant* feature—the *dilatation of the stomach*—as is illustrated by the following quotations:

"The autopsy on Fagge's now celebrated case showed that 'the coils of all intestine were without exception contracted rather than dilated.' Jessop (*Lancet*, 1888) found the 'stomach, *duodenum* and first six inches of the jejunum were enormously distended, the rest of the bowels being collapsed and small.' Nothing else was found. Hood found a like state of affairs. H. Campbell Thomson, whose monograph on this subject stands out as a classic, after collecting 44 cases from the literature and adding 5 of his own, says, 'In the majority of cases there are no signs whatever after death of any obstruction of the pylorus or intestines below.' The appearance of the intestines varies. In a large number of cases either a part or the whole of the duodenum shares in the dilatation, in several cases dilatation has been noted as stopping short at the point where the superior mesenteric artery comes into relation with the bowels. 'Usually with the exception of the duodenum the coils of intestine appear flattened and collapsed.'

"Stewart (*Lancet*, 1903), 'The stomach was found to have a capacity of 10½ pints. There was no evidence of stenosis anywhere.'

"Box and Wallace found 'The stomach and part of the duodenum dilated.' 'The dilatation extended to the place where the duodenum came in front of the lumbar spine.' No mention is made of compression by the mesentery or its vessels.

"Appel (1899) found a dilated stomach and collapsed intestine, which was crowded into the pelvis. No stricture was seen at any level.

"Conner (1907), after studying 69 autopsies, states: 'The most noteworthy feature in the post-mortem picture is the enormous size of the stomach.' In one instance it is described as reaching into the true pelvis.

"Definite obstruction at the pylorus was found only three times, once by a tumor (Thomson), in one case it was due to a band of mesentery (Riedel) and once the obstruction resulted from adhesions (Riedel).

"A part or the whole of the duodenum was found dilated in 38 cases (55 per cent.). In 19 of the 38 cases in which the duodenum was dilated the dilatation *stopped abruptly* near the lower end of the duodenum, where it passes behind the root of the mesentery, and definite obstruction existed there by the pinching of the gut between the mesentery and its contained superior mesenteric artery and the aorta and vertebral column behind. In 8 cases there was dilatation of the duodenum *but no compression by the mesenteric artery was noticed*. The small intestine below the duodenum is usually collapsed. Moschcowitz noted in an autopsy on his patient that the dilatation of the duodenum 'ended abruptly at the point where the superior mesenteric artery crossed the duodenum, the artery standing out like a whip-cord. Below this point the small intestines were collapsed.'

In many of the autopsy records which were reviewed by Laffer and Conner no mention was made of the condition of the small intestine.

ACUTE DILATATION OF THE STOMACH

Many theories have been advanced and some experimental work has been done to prove each. The principal theories that have been advanced have been the following:

- (1) A primary paralysis of the stomach.
- (2) Mechanical obstruction by the mesentery and mesenteric vessels.

In support of each we have many authorities. Brinton in 1859 first offered the theory of primary paralysis of the stomach, and later it was emphasized in the work of Braun and Seidel, Goodhart, Thomson and others. In 1887 Hunter, of New York, stated, "The cause of this condition is very obscure."

The mechanical obstruction by the mesentery and the mesenteric artery presupposes a collapse of the small intestine and its gravitation into the pelvis, thus dragging on the mesentery, which causes the superior mesenteric artery to act as a constricting band, thus obstructing the lumen of the duodenum. Kundrat (1895) is credited with having been the first to describe an incarceration of the duodenum between the mesenteric artery and the vertebral column as an autopsy finding in three cases of acute dilatation of the stomach.

This theory is supported by Albrecht and, as we shall see, by many others. Thomson says, "Albrecht describes how in the dead body the possibility of the superior mesenteric artery acting as a constricting band may be easily demonstrated by putting a finger in the intestine and then pulling on the mesentery, and he also describes how the same effect may be produced by stretching the mesentery by means of a small weight." "I have been satisfied myself that it is possible to produce an obstruction in this way after death, but *I do not feel at all sure that the conditions liable for its production are likely to exist very often during life*" (Thomson). "In the first place it requires a considerable amount of force to produce obstruction in this way. Second, the intestines are not always contained in the pelvis or other situation in which they are likely to cause traction. Third, against the view that constriction occurs through the medium of the superior mesenteric artery is the fact that the position of the apparent obstruction, shown by the dilatation terminating abruptly, is not a constant one."

In 1900 Byron Robinson, of Chicago, "without knowledge of the literature" and after a study on the cadaver, lasting from 1893 to 1900, of the manner in which the transverse segment of the duodenum was compressed by the superior mesenteric artery, nerve and vein, states, "that when the coils of the enteron lie in the pelvis the superior mesenteric artery, vein and nerve compress the transverse segment of

the duodenum in such a manner that gastroduodenal dilatation begins in the transverse segment immediately on the right side of the superior mesenteric vessels and nerve." "I have observed this so frequently," he says, "in autopsies that I know it to be an important factor in gastroduodenal dilatation in persons suffering from ptosis."

Thomson in 1900, after collecting 44 cases from the literature, states, "The immediate cause of acute dilatation of the stomach probably depends upon *some disturbance of the nervous system which gives rise to paralysis* of the muscular walls and which also frequently causes excessive secretion into the stomach cavity."

In 1902, Thomson cited a case in which eight feet of the intestine was dilated, as evidence against the obstruction by the mesenteric vessel theory, and he said at that time, "While in no way denying that some cases may be obstructive in origin, I am *inclined to believe that a primary paralysis of the organ must be regarded as the underlying cause* in the majority of cases."

Thomson says, "Goodhart brought forward notes of all cases of dilated stomach not due to pyloric obstruction in the post-mortem room of Guy's Hospital from 1875 to 1882, and, in the light of general information obtained from these, Goodhart concluded that *paralysis of the viscus is*, if not the determining cause, at *any rate an accompanying condition*."

Box and Wallace (1901) expressed the opinion that the "condition is due to, first, a paralytic condition of the viscus which leads to distention and then, at a certain stage, the distended stomach actually produces obstruction by pressing on the duodenum on the front and to the left of the spinal column." This conclusion is supported by their experiments on the cadaver. "We have found," they say, "by actual experiments on the cadaver that the stomach can be enormously distended by water pressure, with the jejunum cut right across and lying patent in the abdomen. Moreover, the stomach remains distended. *The same result can be attained after the superior mesenteric vessels and peritoneal folds in their neighborhood have been divided. If the stomach to the left of the median line be gently raised the distention of the stomach cannot be produced.*"

MacEvitt, of New York (1906), believes that "whatever the cause may be there is a paralytic dilatation underlying it, caused by some agent acting upon the central nervous system."

Conner (1907) says, "It seems to have been clearly demonstrated within the last few years that a very important cause, perhaps the most

ACUTE DILATATION OF THE STOMACH

important single cause, of such stomach dilatations is the sudden incarceration of the lower end of the duodenum between the root of the mesentery which passes in front of it and the vertebral column behind." Despite this assertion his own collected material showed such a condition in only 55 per cent. of the cases.

Laffer (1907), after studying 217 cases, concluded as follows: "The pathology and *modus operandi* of acute dilatation of the stomach and gastromesenteric ileus is not definitely known, but the experimental, clinical and pathological evidence points to a primary innervation disturbance, affecting the gastric nerves or their centres in the brain or cord." *It has not been proven that the compression of the duodenum by the root of the mesentery is the primary cause of the so-called arteriomesenteric ileus. Only 27 of Laffer's cases showed compression by the mesentery.*

H. B. Smith (1907), after a study of six personal cases, all abdominal, says the "evidence is against a mechanical process as a primary causative factor." "The weight of evidence favors a primary gastro-intestinal paralysis, manifesting itself most severely in the stomach on account of the anatomical relations of that organ. The paralysis may be central or peripheral, or both." Mesenteric compression if present is secondary.

McWilliams says (1908), "Evidence is strongly in favor of acute dilatation of the stomach being primarily an innervation disturbance."

J. M. T. Finney (1907) summarized the situation well when he says, "That the obstruction produced by a tense mesentery and superior mesenteric vessels is one cause of acute dilatation of the stomach, will, I think, be generally admitted, but that it is the sole etiologic cause or even the primary factor in its production has not been established."

In my case, as there was no evidence of mesenteric obstruction and as the preponderant evidence points to a primary innervation disturbance, it may be well to inquire how this could account for everything. We have a condition analogous to a dilatation of the stomach without obstruction in dynamic ileus. This analogy has been previously pointed out by Borchgrevink. According to Cannon and Murphy, "Dynamic ileus occurs whenever the intestines become paralyzed, parietic or spastically stenosed." "Is the location of dynamic ileus central or peripheral?" "In dynamic ileus we are dealing with a failure of normal peristalsis. The alimentary canal can perform its motor functions for some weeks almost normally when wholly disconnected from the nervous system, yet according to Magnus, all spontaneous and reflex movements cease when Auerbach's plexus is removed. Con-

sequently, anything which would injure this mesenteric plexus would necessarily result in a cessation of peristalsis."

It seems fairly certain now that the splanchnic nerves, acting through the sympathetic, are purely inhibitory nerves for the intestine. "Strong impulses through the splanchnic nerves, therefore, may be regarded as another cause of gastric and intestinal inactivity."

The stomach derives its nerve supply from the vagi and the splanchnic nerves. Stimulation of the vagi gives rise to peristaltic movements, while the stimulation of the splanchnic nerves brings the movement to a standstill. It has been shown experimentally by Carrion and Hallion "that section of the pneumogastric nerves in the dog leads to dilatation of the stomach and part of the oesophagus."

Thomson further says, "The nervous connections between the vagi and the abdominal plexus are very complex and it is not impossible that the paralysis which involves the stomach may also extend a variable distance along the intestine." Another fact of importance which has been suggested by Thomson is that "once distention has taken place many secondary conditions can arise. The pressure on the surrounding viscera is very great and secondary obstruction of the bowel might be produced without much difficulty."

In order not to unduly prolong this discussion it may be well to state some facts in summary:

(1) The nerve supply of the stomach and intestines is intimately connected.

(2) The inhibitor nerve supply of the stomach and intestine is identical—the splanchnic.

(3) Strong impulses applied to the splanchnics cause a cessation of peristalsis.

(4) Whether these impulses be the result of trauma, infection or what not, the effect here, as in shock, is the same—an acute dilatation of the stomach, with or without dilatation of the duodenum and, in some instances, part of the jejunum.

(5) Obstruction by the mesentery and its vessels is not present in over 50 per cent. of cases.

(6) For the above reasons it seems most plausible that we are dealing with a disturbance of innervation, rather than a mechanical obstruction due to compression by the mesentery and its vessels.

BIBLIOGRAPHY

- Conner: American Journal of Medical Sciences, 1907, vol. cxxxiii.
 Box and Wallace: Lancet, 1901, vol. ii, 1259.
 Brown, W. H.: Lancet, 1899, vol. ii, 1017; 1890, April 19.

ACUTE DILATATION OF THE STOMACH

- Hood: *Lancet*, 1891, vol. ii, 1389.
 Jessop: *Lancet*, 1888, vol. i, 726.
 Box: *Lancet*, 1908, vol. i, June 4.
 Stewart: *Lancet*, 1903, vol. i.
 Turner: *Lancet*, 1905, vol. i, 292.
 Thomson, Campbell: *Lancet*, 1902, p. 287.
 Herrick: *Journal American Medical Association*, 1906, March 31.
 MacEvitt: *New York State Journal*, 1906, vol. vi, 284.
 Mayo: *Journal American Medical Association*, 1905, xlv, 1211.
 Ochsner, A. J.: *American Journal Medical Sciences*, 1906, cxxxii.
 Appel: *Philadelphia Medical Journal*, 1899, August 12.
 Bloodgood: *ANNALS OF SURGERY*, 1907, vol. ii, 736.
 Transactions Association of American Physicians, 1906, vol. xxi, p. 601.
 Torbert, J. R.: *Boston Medical Journal*, 1909, clxi, p. 217.
 Smith: *Boston Medical Journal*, 1909, vol. clxi, 529.
 Sherwood: *Long Island Medical Journal*, 1910, iv, p. 22.
 Seelig: *Interstate Medical Journal*, 1907, xiv, 517.
 Root: *Denver Medical Times*, 1907, xxvii, p. 231.
 Polak: *New York Medical Journal*, 1909, lxxxix, 1184.
 Miller, C. J.: *New Orleans Medical and Surgical Journal*, 1907-1908, lxi, 629.
 Heppertin: *Western Medical Review*, Omaha, 1911, xvi, 21.
 Halsted, A. E.: *ANNALS OF SURGERY*, 1906, xliii, 469.
 Grandin: *American Journal of Obstetrics*, 1909, lix, 1037.
 Gibson, C. L.: *St. Luke's Hospital, Medical and Surgical Reports*, London, 1908, i, 80.
 Ferguson: *American Journal Obstetrics*, 1902, xlvi, 247.
 Thomson: *Discases of the Stomach*, 1900.
 Bettmann: *Lancet Clinic*, 1897, xxxviii.
 Fagge: *Guy's Hospital Reports*, 1873.
 Robson and Moynihan: *Discases of the Stomach*, 1901.
 Wright: *Practitioner*, 1897, vol. vi, 598.
 Eichberg: *Lancet Clinic*, 1900, vol. xlv, 8.
 Robinson: *Lancet Clinic*, December, 1900, p. 577; *Boston Medical Journal*, vol. clv, p. 107.
 Bellion: *British Medical Journal*, 1903, vol. i, p. 74.
 Cooper: *British Medical Journal*, 1903, vol. — 910.
 Campbell: *British Medical Journal*, 1902, vol. i, 324.
 Broadbent: *Practitioner*, 1898.
 Weber: *Lancet Clinic*, June 4, 1898.
 Seelig: *International Medical Journal*, 1907, p. 517.
 Finney: *Boston Medical Journal*, August, 1906.
 Halsted: *Journal Surgery, Gynæcology and Obstetrics*, 1906, vol. ii, p. 13.
 McWilliams, C. A.: *Journal Surgery, Gynæcology and Obstetrics*, 1908, vol. vii, 294.
 Codman: *Boston Medical Journal*, 1908, p. 503.
 Houston: *American Medical Association*, 1908, vol. ii, 1424.
 Moorhead: *American Medical Association*, 1909, vol. i, 1896.
 Laffer: *ANNALS OF SURGERY*, March, 1908.
 Coates: *Lancet*, 1900, vol. ii.

ISIDORE COHN

- Thomson: Lancet, 1901, vol. ii, p. 1113.
Albutt: Lancet, 1902, vol. ii, 323.
Halsted: Johns Hopkins Bulletin, 1900.
Hunter: Boston Medical Journal, 1887, vol. cxvii, 1881.
Streit: American Journal of Medical Sciences.
Patterson: Journal American Medical Association, vol. xlv.
Fairchild: New York Medical Journal, 1909, lxxxix, 801.
Eskridge: Texas State Journal of Medicine, 1908, iv, 316.
Blain: Journal Michigan Medical Society.
Kemp: Medical News, New York, 1904, lxxxv, 249.
Cannon, W. B., and Murphy: Journal American Medical Association, 1907,
vol. xlv.
Lenender: Journal American Medical Association, 1907, vol. xlv.
Munro, J. C.: Journal American Medical Association, 1907, vol. xlv.

REVERSAL OF THE CIRCULATION IN THE LOWER EXTREMITY

BY J. SHELTON HORSLEY, M.D.

OF RICHMOND, VIRGINIA

THE therapeutic value of attempts to reverse the circulation in the extremities has been freely discussed since this work was first brought to the attention of surgeons by the experiments of Carrel. Carrel and Guthrie in a paper in *ANNALS OF SURGERY* for February, 1906, reached the following conclusions as the result of two experiments: "(a) The valves prevent, at first, the reversion of the circulation in the veins. (b) After a short time, the valves gradually give way and the red blood flows through the veins as far as the capillaries. (c) Finally it passes through the capillaries and the arteries are filled with dark blood. Probably dark blood also returns from the capillaries towards the heart through some veins. (d) Practically complete reversal of the circulation is established about three hours after the operation."

In the fall and winter of 1914, I undertook a series of experiments on animals to determine if possible whether the arterial blood when switched from artery to vein reached the ultimate capillaries of the foot. This was done by severing the femoral artery and the femoral vein, in a dog, below Poupart's ligament and uniting the cardiac end of the artery to the distal end of the vein by end-to-end suture. The other ends of the artery and vein were ligated. The technic of suture employed is described in *Surgery, Gynecology and Obstetrics*, for May, 1914, and more fully in *Surgery of the Blood-vessels*, published by the C. V. Mosby Company, St. Louis, Missouri, 1915. The animals were killed at periods of time varying from a half hour to forty-six days after operation, and a cinnabar mass was injected into the reversed circulation just above the anastomosis. An X-ray photograph was taken and then a bismuth mass was injected into the abdominal aorta, after which another röntgenogram was taken including both hind extremities. The specimens were dissected by Dr. R. H. Whitehead, professor of anatomy in the University of Virginia, who found the dissections corresponded on the whole fairly accurately with the X-ray findings. Our experiments were published in the *Journal of the American Medical Association* for March 13, 1915. Dr. De Witt Stetten, of New York, worked on the same problem, using limbs that had been

amputated for affections in which reversal of the circulation has formerly been recommended. In his excellent article (*Surgery, Gynecology and Obstetrics*, April, 1915) which goes very fully and carefully into the literature of the subject, he arrived at the same conclusions to which our experimental work had led us.

Since then I have had one other animal in which reversal of the circulation was done in the left hind extremity, and the dog killed after sixty-nine days, which is twenty-three days longer than the oldest experiment in our former series. The findings substantiate the conclusions we had formed. The cardiac end of the femoral artery was united to the distal end of the femoral vein about two and one-half inches below Poupart's ligament. Sixty-nine days after operation the dog was killed under ether, the carotid being allowed to bleed while salt solution was being injected into the external jugular vein. A cinnabar and bismuth mass was then injected into the femoral artery about an inch above the point of anastomosis. The artery was tied and röntgenograms were taken. The systemic arterial circulation was then injected through the carotid with bismuth mass and a röntgenogram taken.

In the earlier series we sometimes did not secure satisfactory results, because the mixture was too weak in bismuth or gelatin or because the vessels were left untied. It is important to have a 10 per cent. gelatin solution and as much bismuth as will permit the hot gelatin solution to flow freely. It should, of course, be injected hot. Both ends of the femoral should be ligated immediately after injection, and, if the dog is bled to death and the external jugular vein is opened in the neck, the vein should be ligated before the injection is begun; else much of the mass that is injected in the reversed circulation will flow freely out of the external jugular. The second injection mass should be given through the carotid in the neck instead of the abdominal aorta, as was done in our first series.

The first picture shows a reversed circulation injected half an hour after operation. It will be seen that there is a tendency for the mass to return in the general direction of the branches of the internal iliac vein. The systemic injection (Fig. 2) shows that the collateral circulation is ample to carry the mass into the foot and to fill the saphenous artery of the dog even a half hour after the main trunk of the femoral has been severed. Fig. 3 shows the reversed circulation sixty-nine days after operation, with the mass returning through the large channels into the iliac veins and the vena cava. It will be noted that the mass stops abruptly below the knee. Fig. 4 shows the vena cava containing most



FIG. 1 — Cinnabar mass injected into the reversed circulation, half hour after operation. The X-ray shows that the mass goes only a little below the knee and returns in the back part of the thigh toward the branches of the internal iliac vein. Only a short stub of the artery is shown, as the ligature was tied just above the point of anastomosis. There is, however, very slight, if any, diminution in the calibre of the artery at the point of union.



FIG. 2.—Both hind extremities of the dog shown in Fig. 1 after injection of bismuth mass through the abdominal aorta. Note the excellent circulation in the leg by collateral arterial branches only a half hour after the main trunk of the femoral had been put out of commission.



FIG. 3.—Cinnabar and bismuth mass injected into the reversed circulation of a hind extremity of a dog sixty-nine days after reversal of circulation. The exposure is short, permitting the bone and the small branches to be well shown. Note the abrupt termination of the circulation about half-way between the knee and ankle and the large anastomotic channels running back to the branches of the iliac vein.



FIG. 4.—The same dog as in Fig. 3. The exposure is longer, obliterating the finer vessels and bone, but shows the iliac veins and vena cava fully distended with the mass that was injected into the reversed circulation. Note also the constriction at the junction of the artery and vein, indicated by an arrow, as compared with the large opening in Fig. 1, a half hour after operation.

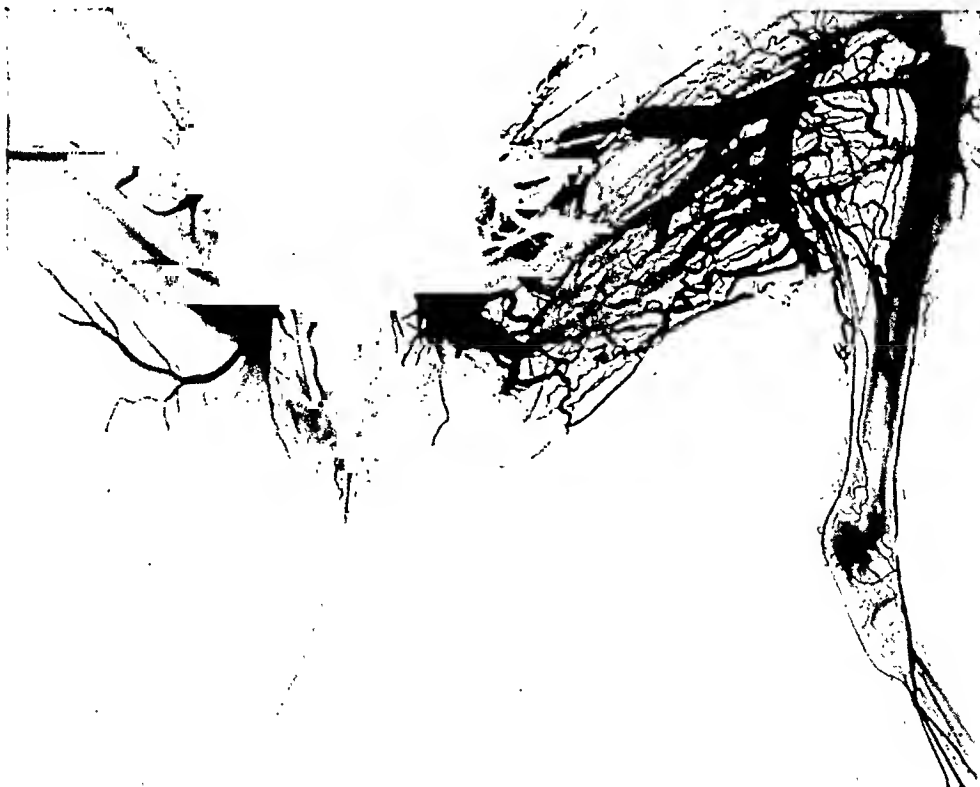


FIG. 5.—The same dog as shown in two preceding figures after the systemic arterial system had been injected with bismuth mass through the carotid. Note the excellent arterial circulation in the foot. The black shadow of the body is probably due to a rupture of some abdominal vessel toward the end of this injection, which filled the peritoneal cavity with the bismuth mass.

REVERSAL OF THE CIRCULATION

of the mass injected into the reversed circulation. Fig. 5 shows the systemic arterial circulation injected from the carotid after the reversed circulation had been injected.

Evidently what happens is that the large valves are first quickly broken down. The arterial blood in the reversed vein then rushes into smaller veins. The smaller valves in the small veins require relatively more force to overcome them than the larger valves in the large veins, because of the relation of cubical contents to square surface. The experiments show that the circulation went but little further down the leg in this dog sixty-nine days after operation than it did in the dog that was injected the first half hour after the circulation was reversed. This seems to show that the valves which are not broken down in the first few minutes will probably hold permanently. Collateral circulation quickly increases, and large veins are formed which readily carry off the reversed blood to the branches of the iliac veins. In this way the pressure upon the obstructing valves is reduced and probably some thickening of these valves occurs. Instead, then, of constant pounding of the heart tending to break down these valves, it seems to do just the opposite. Valves that are not overcome within the first few minutes have less and less pressure upon them until the collateral circulation develops to its maximum. Another interesting point is the tendency of the communication between the artery and vein to close, as shown in Figs. 4 and 5, whereas in a section of a vein transplanted between the ends of an artery this tendency to contraction does not seem to exist.

The beneficial results that are obtained from the reversal of the circulation in threatened gangrene are clearly due to the fact that obstruction of the venous circulation causes the arterial blood to remain in the tissues longer than it otherwise would. The same result can be obtained more accurately and with less danger by ligation of the femoral vein under a local anæsthetic. This procedure has been carried out by von Oppel, Coenen, Lilienthal and others.

THE CONSERVATIVE TREATMENT OF GANGRENE OF THE EXTREMITIES DUE TO THROMBO-ANGIITIS OBLITERANS *

BY WILLY MEYER, M.D.

OF NEW YORK

ATTENDING SURGEON TO THE GERMAN AND POST-GRADUATE HOSPITALS

TWENTY-FIVE years ago, in the spring of 1890, I had under treatment in the wards of the German Hospital, a patient, a tailor, in the early thirties, with thrombo-angiitis obliterans of the right lower extremity. There was no pulse in the anterior and posterior tibial arteries, nor in the popliteal. Gangrene of several toes had set in. The persistent severe pain, increasing during the night, could not be controlled. The proposed amputation of the thigh was at once accepted and done. The severe pain promptly disappeared. He could sleep again, and recovered without interruption. About six months later the identical phenomena were noticed on the opposite side. The principal subjective symptom, found in almost all of these cases, the constant severe pain, again proved obstinate. Hypodermic and internal medication of all kinds were tried without giving relief. The patient reëntered the German Hospital for the express purpose of having the second thigh amputated. He begged for it, and I, not knowing of anything else to relieve his suffering, gave in. This case made a deep impression upon me at the time, and has always remained in my memory. I could never forget the sad picture of the poor fellow going home in that crippled condition. From that time on I have followed with keenest interest every new development in the pathological anatomy and therapeutics of this tormenting, terrible affection.

It was but natural that the therapy of this chapter should turn toward conservatism in its further evolution. There is no surgeon alive who would not willingly try anything and everything that offered a fair chance of saving the limb without endangering the life of the patient.

In 1893 Bier's treatment was introduced. Artificial hyperæmia by means of superheated air—baking—was given a careful test by me in cases of gangrene of the toes and other portions of the foot, due to thrombo-angiitis, but proved of little benefit. Now and then the con-

* Read in part before the New York Surgical Society, May 12, 1915. Inasmuch as further observations were made since then, the subject was again brought up for discussion before the Section on Surgery of the New York Academy of Medicine, November 5, 1915.

GANGRENE DUE TO THROMBO-ANGIITIS OBLITERANS

comitant pains were alleviated and wound conditions improved, but the results were not such as to justify recommendation of Bier's treatment, in any one of its forms of application, as a real help in the therapeutics of this type of gangrene.

Then blood-vessel surgery came in and was taken up with great interest here and abroad: Arteriovenous anastomosis of the femoral and brachial vessels (Wieting) and, later, ligation of the femoral (or brachial) vein in cases of spontaneous gangrene of the extremities (von Oppel). A huge literature has developed on this subject. The gist of it is that both procedures have their failures and their successes. In other words, both are still on trial. To condemn anastomosis on basis of radiographs of limbs the blood-vessels of which had been injected with colored fluid in a reverse direction (Horsley and Whitehead, Stetten)¹ does not appear justifiable. The closing of valves found in these experiments is, no doubt, a correct and indisputable observation. How the closing of these valves could be overcome by the newly established blood current cannot well be imagined. The blood certainly does not circulate through the extremity after the arteriovenous anastomosis has been established in a direction opposite to normal. "Reversal of the circulation" appears, therefore, a term not well chosen, for most likely nothing of the kind occurs. However, what evidently *does* occur after an arteriovenous anastomosis and what I imagine did occur in my case, to be reported below, when the downwardly directed arterial blood stream was being obstructed by the closing of the valves in the femoral vein, is the deflection of this arterial stream into branches of the femoral vein that have no valves; its splitting up into many small streams through thin-walled blood-vessels, that are enlarged *ad maximum* under the high arterial pressure, and the consequent arrival of the arterial blood at the seat of disease in a non-spurting, venously even flow, that continues uninterruptedly. It is but natural that the arterial blood will find its way down to the foot and toes. Wherever no valves are encountered, the stream will flow, driven by the "vis a tergo" derived from the left heart. Of course, some of this blood will run back, by way of collaterals, to the proximal end of the ligated femoral vein,

¹ Horsley and Whitehead injected a hot 10 per cent. solution of cinnabar-gelatin, by means of the gravity method, into the distal end of the femoral artery, about one inch above the anastomosis previously made. Before the injection the remnant of the blood was leached out with salt solution, the dogs having been bled to death under ether (*Journal Am. Med. Assn.*, March 13, 1915). Stetten selected an emulsion of red oxide of lead in paraffin oil, equal parts. He used the hand syringe for injection of the femoral vein immediately after amputation (*Surg., Gyn. and Obstet.*, April 15, 1915).

and from there to the inferior vena cava and the right heart. However, in spite of this leak, enough blood evidently reaches the periphery of the extremity in favorable cases, to restore the impaired nutrition. The return of the blood occurs, I think, through such branches of the venous system as have not been seized upon by the arterial blood. In other words, I believe that some of the lateral contributing branches of the femoral vein and their subdivisions carry the arterial blood down to the most distant parts of the extremity, and that other parts of the venous system of the extremity allow it to return to the heart.

With reference to the best method of vessel suture I believe that the termino-terminal anastomosis (end-to-end) is preferable to the latero-lateral (side-to-side).

I am, therefore, in agreement with those who maintain that upon the results of color-injections, made as described, no definite conclusions should be based as to the usefulness of arteriovenous anastomosis. Such injections cannot be compared with the physiological circulation of the blood in the living body—the result of the gentle work of the heart, according to the laws of nature, with its 60–70 beats every minute. Here certainly one authentic case of thrombo-angiitis obliterans successfully operated upon by vessel anastomosis and completely restored is of more importance than all adverse reasoning, no matter how clearly presented. And we have many successful cases of this kind.

I could personally present such a patient to-night, a typical case of thrombo-angiitis obliterans with subsequent local gangrene, in the young. Ligature and division of the femoral artery and vein in Scarpa's triangle and end-to-end anastomosis between the proximal stump of the artery and the distal one of the vein cured the patient completely. During the excision of the first metatarsal bone and of the necrosed big toe, that had to be done ten days after the "Wieting" on account of intolerable pain, there was observed by me and those present at the operation, a distinct arterial hemorrhage from the lateral veins of the toe, requiring ligation. There was no spurting; but there was a continuous flow of unmistakably arterial blood from the divided veins on either side of the first metatarsal bone. No better proof than this could be had of the fact that the arterial current, driven by the continuous beating of the heart, had overcome the obstacles in the venous system and then appeared with such force at the most distal end of the foot that the vessels had to be secured. Of course, I am unable to prove that this circulation has continued without obstruction, that not *at present* a thrombosis of the femoral vein is responsible for the excellent condition of the

GANGRENE DUE TO THROMBO-ANGIITIS OBLITERANS

extremity and the patient in general, two and a half years after the operation.

If ligation of the femoral vein will usually show satisfactory results, let us then by all means discard the arteriovenous anastomosis and do the ligation, which in its technic is much simpler than the anastomotic operation.

However, as stated above, both operations are still on trial and should be further tested whenever the simpler means in the step-ladder of attempts to save the limb fail.

One of these "simpler means" which really prompted me to write this paper, is to be mentioned now: the methodical hypodermoclysis of saline, or Ringer's solution. Chronologically, it made its appearance after blood-vessel surgery had been taken hold of in connection with the subject in question; clinically, it should take precedence to the former.

In the summer of 1913, shortly after I had done the arteriovenous anastomosis in the case cited above, I chanced to come across the article by G. Koga, of the Surgical Clinic of Professor Ito, of Kyoto, Japan ("Zur Therapie der Spontangangraen an den Extremitäten," *Deutsche Zeitschr. f. Chirurgie*, vol. cxxi, p. 371). The paper gives a brief report of thirteen cases of thrombo-angiitis obliterans in younger patients, every one of whom was benefited by these hypodermoclyses.

Explaining the action of the injections, Koga thinks that they change the viscosity of the blood. In other words and plain language: thick blood is made thin. I have had some correspondence with Professor Ito, a gentleman of great learning, whom I had the pleasure of meeting here in New York ten years ago, regarding this interesting question of blood viscosity. I have also had frequent discussions on the subject with Dr. A. L. Garbat, the serologist of the German Hospital. He, in turn, consulted Professor Burton Opitz, of Columbia University, who, as is well known, has done a great deal of experimental work in this chapter. The latter stated that there is as yet no accurate clinical method of viscosity estimation. (In animals, when the blood-vessel can be exposed and opened, accurate findings may be recorded.) The fine differences reported by various observers are most probably inaccuracies caused by mechanical features of the instruments they employed. Only striking differences may be considered, but then these can just as well be determined by comparative estimations of the hæmoglobin and the total number of red blood-cells, variations of which usually go hand-in-hand with variations of the viscosity.

What kind of instrument was employed by our Japanese colleagues is not stated in Koga's article. However, one year before his paper

appeared, an interesting essay on this question was written by T. Mayesima, also an assistant at Professor Ito's Clinic, "Klinische und experimentelle Untersuchungen über die Viskosität des Blutes" (*Mitteilungen aus d. Grenzgebieten, etc.*, vol. xxiv, 3 pages, 413). He used the viscosimeter of Hess,² which permits of reading the relative degree of the viscosity of the blood by comparing the quantity of the blood with the quantity of water running through the apparatus within a certain space of time. Koga likely used the same instrument for his tests.

Two of Mayesima's conclusions read:

1. Saline infusions reduce the viscosity of the blood.
2. In spontaneous gangrene of the extremities the viscosity of the blood is more or less increased. If the increased viscosity is reduced by saline infusion, the gangrene is influenced favorably.

As Professor Ito wrote me, it had been on basis of this article that Koga, at his (Professor Ito's) suggestion, tried the hypodermoclysis clinically. Hence, if we want to give a name to the method we shall have to call it "the Mayesima-Koga treatment."

In the course of the last two years systematic hypodermoclysis with Ringer's solution has been tested in my division of the German and Post-Graduate Hospitals, as an adjuvant in the conservative treatment of gangrene of the extremities. I advisedly do not repeat here the more specific wording of the title of this paper, because we have tried to find out the merits and demerits of the injections *in the various types* of gangrene of the extremities, same as we did with the superheated air in previous years.

Before continuing with the main subject under discussion, I should like to make a few remarks on the experience we have had with superheated air and systematic hypodermoclysis in the conservative treatment of other types of gangrene of the extremities:

I. In those acute, rather fulminant cases of gangrene following embolism of the main artery of the extremities, as we see it occur in cases of chronic heart disease, that tend to the formation of fibrinous deposits on the endocardium, which latter then are driven as emboli into the arterial system; and

II. The more subacute and chronic types: Diabetic; angiosclerotic, also called arteriosclerotic or senile; syphilitic; and trophoneurotic or neuropathic gangrene.

I. Acute Gangrene.—I have seen five cases of acute gangrene following embolism. Three times the axillary artery was involved, once the femoral and once the descending aorta. Only in two of these cases

² Muench. Med. Wochenschr., 1907, Nos. 32 and 45.

could a treatment of the patient with superheated air be arranged for. In the first case, a female patient, seen very early after the onset, the effect was splendid; not even part of the third phalanx of any finger was lost. In the second case, that of a man with pronounced myo- and endocarditis, whom I was called in to see in about the third week of his severe illness, the treatment also brought great improvement. He lost more or less of the end-phalanges of his fingers, but he recovered and is still alive. I believe that systematic baking, commenced *immediately* after the onset of the symptoms, is the conservative treatment *par excellence* in this affection.

The radical procedure is arteriotomy and removal of the embolus (pulmonary artery—Trendelenburg, 1906; common iliac—Murphy, 1909; aorta abdominalis, Bauer, 1913). However, some of these patients will not be in a condition to stand the strain of such an operation.

II. Subacute and Chronic Gangrene.—1. *Diabetic:* Five years ago I could show before the New York Surgical Society and other medical meetings two diabetics whose limbs had been saved from threatening gangrene by the regular use of superheated air, Bier's artificial arterial hyperæmia.³ Both were over sixty years of age. One showed all the precursors of gangrene, involving the toes of both feet: great subjective pain, icy coldness and deep blue hue of the skin, with the pulse in the dorsalis pedis and posterior tibial absent. Upon our advice he used superheated air faithfully for two to three years. He still has all his toes.

In another patient I had to amputate the thigh for a rapidly advancing gangrene of foot and leg. About a year and a half later, he began to show evidences of beginning gangrene of the opposite foot. He absolutely refused further operative interference. I made him use superheated air for a long time. Gangrene did not develop. He later died of pneumonia. I could cite other cases.

Not long ago De Witt Stetten, of the German Hospital of New York, reviewed the subject.⁴ In his article he does not refer to the patients presented by me previously and the efforts I had made to give this conservative method a wider trial. He publishes the histories of seventeen cases.

It is self-understood that baking cannot save the gangrenous limb of every diabetic. The judgment and experience of the trained surgeon must decide whether an attempt at conservatism is still justified, or

³ ANNALS OF SURGERY, 1910, vol. lli, p. 713.

⁴ Jour. Am. Med. Assn., 1913, vol. lx, p. 1126.

whether amputation should be promptly carried out. The chances of benefit from superheated air are certainly greatest in the very beginning of diabetic gangrene, for we must remember that its effect is the re-opening of collapsed capillaries by the creation of sufficient collaterals to carry on nutrition of the threatened parts.

Neither hypodermoclysis nor blood-vessel surgery seems to have any *raison d'être* in this type of gangrene. The latter remark holds good also for:

2. *Angiosclerotic (arteriosclerotic or senile) gangrene*: Last year I tried hypodermoclysis in a man sixty-four years of age, who had had his left thigh amputated for gangrene three years previously. He had neither syphilis nor nerve trouble, but presented a plain case of arteriosclerosis. He came again with painful trouble in the other leg; the toes, particularly the big one, were cold and blue. I tried hypodermoclysis rather as an experiment. His pain was much relieved. Under further continued superheated air treatment, he shed the nails of all five toes and grew healthy nails instead; surely a sign of good circulation in a region farthest away from the heart. However, one year later, his pain returned, and the discoloration of the big toe reappeared. Six months ago the toe was removed, without giving him relief. Four weeks later the leg had to be amputated.

I tried the conservative treatment with hypodermoclysis in another patient with acute senile gangrene; but ascending thrombosis set in, amputation became necessary, and the patient died.

In acute senile gangrene I would not advocate any other treatment than prompt amputation, best above the knee. If the trouble appears *gradually*, superheated air may stave off amputation for a while.

3. *Syphilitic gangrene*: In this class of cases an antispecific régime—salvarsan, mercury and iodates—should be tried in conjunction with baking. We know that arteriosclerosis, particularly in older syphilitic subjects, with gradual occlusion of the affected vessel in consequence of endarteritis syphilitica, is the direct cause of poor nutrition of the peripheral parts of the extremity.

4. *Trophoneurotic (neuropathic) gangrene*: If any chapter of the interesting question of local gangrene deserves further careful investigation as to its etiology, it is the one believed to be due to vasomotor irritation in the cord (Raynaud).⁵ Weir Mitchell's erythromelalgia

⁵ Last year H. N. Collins, of New York, wrote an excellent collective article on the various types of circulatory disturbances in the extremities. He endeavors to clear up this chapter with reference to symptomatology and pathology. *ANNALS OF SURG.*, vol. ix, p. 742.

GANGRENE DUE TO THROMBO-ANGIITIS OBLITERANS

is ascribed to the same cause, but does not produce gangrene. We know that syringomyelia, locomotor ataxia and peripheric neuritis, can produce a trophic ulcer. We are always ready to hold the nervous system responsible when all of the above mentioned causes have to be excluded.

But just here I think further studies are much needed in order to throw more light on the real cause. Personally I should not be surprised, if in cases hard of explanation *an affection of the blood as such* often had to be held responsible for the local condition. I refer particularly to the local gangrene of the extremities with non-disappearance of the pulse in the distal arteries: "with patent arteries." We feel a good pulse in the tibial and peroneal artery; still there is gangrene. The person is young; he has neither diabetes nor syphilis. What wonder that we think the nervous system is to blame. Yet, here systematic hypodermoclysis may bring relief. I was able to show a case of this type before this section two years ago.

The man was thirty years old. A brother of his, also in younger years, had had both lower extremities amputated gradatim, feet, legs, thighs, at another hospital; after the last operation he died. My patient had an extremely painful necrotic paronychia of the left big toe. One year before I saw him, the same trouble had existed in the other foot and had taken a long time to heal. The mere touch of the ulcer now caused excruciating pain, and the patient surely did not exaggerate. A neurologist suggested syringomyelia as the cause. Mindful of the sad experience of the other surgeon in his brother's case, I tentatively treated him conservatively. Baking did not reduce the sensitiveness. Having then just read Koga's article, I started methodical hypodermoclysis, after a part of the nail had been removed and the nail bed thoroughly eschared with the actual cautery under general anæsthesia. With the dry dressing not touched for several weeks, the hypodermoclyses were given—this was my first case—commencing with saline, then with Ringer's solution, which latter was much less painful. Imagine my surprise when under this treatment, with the first dressing still in place, the pains which had tormented the patient for months and refused to yield to any medicinal treatment, gradually subsided, and healthy, strong granulations were found when the first change of dressing was made, three weeks after the operation. The wound healed, and the patient could return to his business. Eighteen months later, a paronychia appeared on the second toe of the other foot—originally affected—also some general pains in the extremity. The

same procedure as in the case of the local gangrene of the big toe of the left foot, with a second series of hypodermoclyses, was advised and carried out. The patient still has slight painful sensations off and on in the right foot, but is fully able to attend to his work. (He was presented at the meeting in good condition.)

But now to return to the subject under discussion, the typical thrombo-angiitis obliterans, as we find it in younger patients—men who are not afflicted with either diabetes, syphilis or a chronic disease of the nervous system. Many have suffered for a great number of years, five, ten, fifteen. At last they come to us on account of unbearable pains in one or more extremities, usually the lower one—pains that do not yield to any of the remedies of the pharmacopœia, internally or subcutaneously administered. They show local gangrene of one or more toes or fingers, or a portion of the foot, usually in the presence of a reduced or missing pulse in one or both feeding arteries of the foot or hand, often also of the popliteal.

In the course of the last two years I have had some 30 odd patients of this type under my personal observation and care and have seen at least 12 others through the courtesy of colleagues.

Before discussing the experiences I have had in the treatment of these cases, it seems necessary to first touch upon a few points in their histories.

Age.—The patients are usually between thirty and forty years of age; never over fifty.

Sex.—Only male patients are subject to this disease. As far as I know, there is not a single case of *typical* thrombo-angiitis obliterans in the female on record. Those female patients who have been pronounced as suffering from the disease present either—according to my belief—another type of gangrene or have to be looked upon as very rare exceptions.

Nationality.—The majority of these patients are Hebrew immigrants from Russia, Galicia or Poland. Whether or not their American-born offspring become similarly afflicted needs further observation. Buerger has twice seen the affection in the children of these immigrants (personal communication); I have not seen an instance of that kind. Koga⁶ reports the disease among Japanese; Ochsner⁷ among Swedes.

Occupation.—Many of my patients were tailors or cutters, working in the sweat-shops, often using their feet to run machines. For a while

⁶ *Loc. cit.*

⁷ Transactions of the Chicago Surgical Society, Surg., Gyn. and Obstetrics, October, 1915, p. 536.

GANGRENE DUE TO THROMBO-ANGIITIS OBLITERANS

I thought this kind of work might be a causative factor, but later I found that all sorts of trades contribute to these patients. There were bakers, newsdealers, carpenters, salesmen, etc., so that apparently no specific occupation has any particular bearing on the etiology of the disease. However, a majority of them were tailors or cutters.

Habits.—Many of these patients are inveterate smokers. Some told me that they smoked as many as 7 or 8 packs, 70 or 80 cigarettes, per day. All patients observed by me were individuals belonging to the poorer classes, men who live in the tenements. People who live in better surroundings do not seem to become afflicted with this disease.

Pathological Anatomy.—Leo Buerger, of New York, has made a series of most painstaking dissections and careful microscopical studies of the blood-vessels of limbs amputated for thrombo-angiitis obliterans. He found the lumen of the vessels, usually the arteries (though the veins may also be involved, 40 per cent.), narrowed or blocked, due to a distinct thrombosis. The thrombosis begins distally and works up. It does not start in the capillaries or arterioles, but in the next higher groups. He further found that the chief thrombus usually occurs in the popliteal rather than in the smaller vessels (D. C. Strauss, of Chicago, has made a similar observation, *Surg., Gyn. and Obstetrics*, October, 1915, p. 536, Transactions of the Chic. Surg. Soc.). Missing pulsation in the peripheral arteries, therefore, does not necessarily imply occlusion of these vessels. They may remain patent, while the thrombus is found higher up.

Buerger believes that he has demonstrated thrombo-angiitis obliterans to be a clinical and pathological entity, "a process in which an acute inflammatory lesion together with occlusive thrombosis of arteries and veins is the characteristic lesion." He is further of the opinion that the histological changes in the veins point to the existence of an infectious process (some microbial agent).⁸

On basis of my clinical observations, I venture to advance a further explanation: It seems to me that a local thrombosis of the smaller arteries, often also of the veins, must not necessarily have been caused solely by the acute inflammatory lesion of the vessel walls; some change or disease of the blood itself may be responsible for its abnormal tendency to coagulate when it flows through vessels of smaller calibre (see below).

Etiology.—I. *Infection:* On basis of his histological studies Buer-

⁸ Proceedings of N. Y. Pathol. Soc., N. S., vol. xiv, No. 4, April, 1914; *Surg., Gyn. and Obstetr.*, November, 1914, p. 582-588; *Journal of Med. Research*, vol. xxxi, No. 2, November, 1914.

ger, as stated, advanced the theory that thrombo-angiitis obliterans might be of infectious origin. He has done so much research work in connection with this trouble, that his opinion certainly must carry weight. However, in the face of such a theory, it is hard to understand why the disease is not more general; furthermore, why the female sex should be exempt from the infection.

2. *Food*: One might possibly look for an etiological factor in the food. Yet, this would be hard to explain in view of the fact that only male patients are affected, while practically the same food is partaken of by both sexes.

Ochsner found that his patients ate much salted meat. Under a salt-free diet several improved considerably and in several of them the primary necrotic ulcer healed without an operation. He, therefore, leans toward the explanation that the food plays a rôle in the etiology of the disease.⁹ Ito attributes the trouble to the exclusive consumption of vegetables. Many Japanese are vegetarians who, he thinks, develop an insufficient state of nutrition of the walls of the blood-vessels. Wieting expresses the same opinion.

3. *Tobacco*: Some authors incline to the belief that nicotine-poisoning has a great deal to do with the gangrene. As stated above, some of my patients had been smoking 70-80 cigarettes per day. On the other hand, there were just as many who were not addicted to the use of tobacco at all and still showed the same characteristic gangrene. It is a well-known fact that the excessive use of tobacco favors the development of arteriosclerosis; this latter disease, however, has nothing in common with thrombo-angiitis obliterans.

4. *Internal secretion*: Some believe that the disease is due in part to a disturbance in the internal secretions and, therefore, treat these patients empirically with thyroid extract, etc. The fact that women seem to be immune might justify the assumption that something in their system protects them—something that the male sex does not possess. Reflection turns toward the genital sphere. Perhaps the internal secretions from this system, particularly the ovaries, furnish the protection against the effects of the still unknown noxa.

5. *Viscosity of the blood*: Mayesima and Koga hold the degree of the viscosity of the blood responsible for the gangrene. In this connection it is interesting to note that the viscosity in the male is higher than in the female sex.

Further investigation is required to prove this contention, and to find the underlying cause of this difference in the viscosity.

⁹ *Loc. cit.*

GANGRENE DUE TO THROMBO-ANGIITIS OBLITERANS

6. *Quality of the blood as such:* It does not seem plausible that the viscosity of the blood alone should be responsible for the trouble. The tendency to recurrence of the symptoms in some cases, after disappearance under the systematic hypodermoclyses, would seem to speak against such an assumption. As I said before, it is my belief that the quality of the blood itself is altered in these cases and plays an important rôle in the development of the thrombosis. An additional inflammatory condition of the smaller blood-vessels, that lead to the local thrombosis (Buerger), does not necessarily have to be present. Observations have shown that gangrene can set in with the tibial arteries patent and pulsating. (See further down.)

CONSERVATIVE TREATMENT OF THROMBO-ANGIITIS OBLITERANS

1. *Superheated Air.*—So far as the overcoming of pain is concerned, superheated air which is often of such great benefit in diabetic gangrene has, in my own experience, shown no lasting effect upon thrombo-angiitis obliterans. Buerger has seen better results. Dr. H. W. Frauenthal, of this city, states that the heat produced by the white light is more efficient than the ordinary superheated air, as produced by Bier's apparatus.¹⁰ Personally, I have never tried the heat of the white light.

2. *Hypodermoclysis with Ringer's Solution.*—Since the fall of 1913, as mentioned before, I have had some thirty odd of these patients, all of whom were given a series of hypodermoclyses, sometimes repeatedly. Twenty-four injections was the limit we have arbitrarily set down. They were made either every day or every second or third day. One tabloid of Ringer's solution is dissolved in 500 c.c. of *distilled* sterile water. It is absolutely necessary to use distilled sterile water. With ordinary sterilized water we have often seen infiltration and fever to occur. A big long needle has been used. The infraclavicular space, submammary connective tissue and external aspects of the thighs have been the places of application. Starting on one side from above, the opposite side follows in the same sequence, so that every region is subjected to the injections four times. The abdomen and inner aspect of the thighs are less favorable places for this purpose. Local pain and swelling, which easily set in on repeated application at the same place, have been controlled by moist dressings (Priessnitz).

For better observation all these patients were admitted to the ward and remained there until the course of treatment was completed. It is,

¹⁰ Transactions of the Sixteenth International Med. Congress, Budapest, 2d part, p. 906.

of course, a great burden and, at the same time, hindrance to an active surgical service to have these chronic cases occupy beds in the wards. It is advisable to treat them in the dispensary, at an hour other than the usual visiting time. One assistant or one trusted nurse can do the work. In the spring of this year I saw at the Hospital for Deformities and Joint Diseases twelve patients of this type receive hypodermoclyses at the hands of one nurse, a stand, holding two bottles, being placed between each two tables or stretchers. Afterward the patients were allowed to go home. I myself, too, have treated such patients in an ambulatory fashion and have seen no harm result therefrom. Of course, patients with advanced gangrene need hospital attendance.

The effect of this treatment sometimes was remarkable. Often the principal subjective symptom, the ever-present tormenting pain, ceased as if by magic, usually after the tenth to the fifteenth injection, and without any other internal medication, left out on purpose. Hypodermics of pantopon, $1/3$ grain for the dose, as obtainable in ampoules, an anodyne from which I have seen now and then some little effect in controlling the pain, could be stopped. Refreshing sleep—not had for weeks or months—returned, and therewith, appetite, gain in weight, and improvement in the nervous state of the patients. In some the pallor of the face gave way to red cheeks, in the absence of any apparent change in the laboratory findings as to the condition of the blood. (Repeatedly I have been surprised to find in these patients besides a low blood-pressure, that the blood examination at the time of admission to the hospital showed a high percentage of hæmoglobin and an almost normal number of red blood-corpuscles; in fact, there was no disturbance in the morphology of the blood picture.) Hand in hand with general improvement went the local. Often the gangrene became localized and healthy granulations sprang up, without previous local cauterization of the old sores. Ulcerations that had been present for months began to heal slowly—seldom quickly. Slow cicatrization was the rule. Return of the pulse in the arteries of the affected limb was seen very rarely.

In some of the patients—the minority—the improvement has been lasting; in most of them the symptoms, particularly the pain, returned after a while, though in milder form. Almost none of the discharged patients could walk for longer distances: after covering a few blocks, pains in the calves of the leg would set in, forcing them to sit down (persistence of claudication). They, therefore, returned to the hospital for a second course of treatment. Again the result often was favorable.

Koga saw improvement in every one of his thirteen cases. While I am not in a position to report such uniformly satisfactory results, I

GANGRENE DUE TO THROMBO-ANGIITIS OBLITERANS

am ready to say that this treatment deserves a permanent place among the means employed by us in trying to combat thrombo-angiitis obliterans on a conservative basis.

3. *Arteriovenous Anastomosis or Ligature of the Femoral Vein.*—See above.

I believe it might be a good plan to try additional organotherapy by internal administration in every one of these cases, empirically: first thyroid tablets; then pituitary or thymus; finally also ovarian (oöphorin). If none of these alone does any good, the effect of the combined extracts, as offered of late in the hormotone tablets, might be tried.

In reflecting upon the cause of the beneficial effect of the hypodermoclyses upon these patients, one cannot help but feel, as intimated above, that the repeated hypodermic administration of this solution of important salts, besides reducing the viscosity, exerted a definite beneficial influence upon the blood as such, in other words, that the *quality* of the blood was favorably affected.

Starting from this premise, viz., that *the changed quality* of the blood as such plays an important rôle in the etiology of thrombo-angiitis obliterans, we recently went one step further, and tried: (1) blood transfusion (sodium citrate method); (2) repeated intravenous injection of a 2 per cent. watery solution of sodium citrate. Both might probably be done to advantage after a venesection. But this we have not tried as yet.

The injection of sodium citrate solution was tried tentatively on basis of the fact that it will keep blood in a fluid state for a number of days (Hustin, Weil, Lewisohn). I reasoned that, if sodium citrate will prevent coagulation of blood in a container, it ought to do this also, perhaps even better, in the living body, and that repeated injections of watery solutions of this salt directly into the blood, the viscosity of which had been reduced by the hypodermoclysis of Ringer's solution, might lessen for a longer period its tendency to coagulate. If so, then the transfusion of blood would be rendered unnecessary, and the treatment of these patients infinitely simplified. For, as will be shown further on, it is very difficult to find donors with suitable blood for transfusion in these cases. Besides, the majority of the patients are not at all in need of additional blood, in that they usually have, in spite of prolonged sickness, a high percentage of hæmoglobin and satisfactory count of erythrocytes.

It would lead too far, here, to go into details. I hope that Dr. Garbat, whom I was fortunate enough to interest in this question, and who gave much of his time last summer to a study of important points connected with the subject, will soon publish his personal impressions *in extenso*.

The following remarks, quoted in part from Dr. Garbat's report, must at present suffice:

"1. *Blood Transfusion*.—In the selection of donors we met with certain difficulties. It was most difficult to find suitable persons, as in almost all instances the patients' red blood-cells were easily agglutinated by the donors' serum. Of the four cases of thrombo-angiitis obliterans treated, one belonged to the very rare, so-called fourth group, and the other three all belonged to the so-called rare third group.¹¹ For one patient it required the examination of 38 donors to find a suitable subject; for another it required the examination of 40 and for a third even of 54 subjects. (But the blood of each of the three, that belonged to the one group, fitted that of the other for transfusion, a condition that was to be expected.)

"In contrast to this type of gangrene, a patient with arteriosclerotic gangrene, who was to be subjected to transfusion, was fitted with four suitable donors out of six examined.

"The fact that three of the above-mentioned patients belonged to one and the same rare group, and the fourth to a still rarer one, may have been a mere coincidence. At the same time, one might set up the

¹¹ As is well known from the work of Landsteiner and Shattuck, the serum from one human being may agglutinate the red blood-cells of another human being. This phenomenon is known as iso-agglutination (Ottenberg, *Jour. of Experimental Medicine*, vol. xiii, No. 4, 1911). Many workers at first regarded iso-agglutination as of pathological significance. Halban, Ascoli and others, however, showed that iso-agglutination occurs with a large proportion of normal bloods, and Landsteiner discovered the remarkable fact that all human bloods can be divided into three sharply defined groups, according to the way in which they inter-agglutinate. To these groups was subsequently added a fourth, independently discovered by several observers.

The serum of the first group, known as Group I, possesses the power of agglutinating the red cells of members of the other groups, but the red cells of members of Group I are not agglutinated by any human serum. This group includes about 50 per cent. of all persons who were examined as donors.

The serum of members of the second group (Group II) agglutinates cells of persons belonging to the third and fourth groups, but not of members of Group I. The cells of members of the second group can be agglutinated by sera of individuals of Group I and Group III only.

The third group is reciprocal of the second group. Its serum agglutinates cells of persons belonging to members of the second and fourth groups; its cells are agglutinated by sera of the second and first groups.

The fourth group, also a rare group, is characterized by having no agglutinin for the red blood-cells of any of the former groups, and its cells being agglutinable by the sera of all other groups.

The group characteristics are permanent for each individual throughout his life and, furthermore, are hereditary and follow the Mendelian law.

hypothesis that people belonging to the rare third and fourth groups are possibly more susceptible to vascular (or blood) diseases, particularly to the condition known as thrombo-angiitis obliterans.

"2. *Repeated Intravenous Injection of a 2 per cent. Watery Solution of Sodium Citrate.*—Four patients received an intravenous infusion with sodium citrate once per week. One got in ten weeks 13 infusions corresponding to 19.5 grammes of sodium citrate; one got in ten weeks 10 infusions corresponding to 12.5 grammes of sodium citrate; one got in ten weeks 9 infusions corresponding to 13 grammes of sodium citrate; one got in ten weeks 8 infusions corresponding to 9 grammes of sodium citrate.

"Under this treatment the patients claimed that their pains became less, but it must be stated that they had already been favorably influenced by the hypodermoclyses with Ringer's solution.

"The objective findings were: (1) that the blood which at first was very thick, so that it flowed with difficulty through the salvarsan needle, later on came out much more easily; here viscosity tests would have been of importance; (2) one man, whose radial pulse had been obliterated, had a return of radial pulsation.

"As to harmful effects from the sodium citrate infusions, there were none."

This treatment seems encouraging, provided the effect is lasting. Otherwise we must strive to find some other chemical, useful for intravenous injection in this class of patients. At all events, the hypodermoclysis with Ringer's solution should be tried first. If 10 to 15 injections do not improve the local and general condition, the intravenous treatment should be added.

It is our intention to analyze also the cerebrospinal fluid of these patients and compare its composition with that of the blood, and, further, to ascertain the amount of their fibrinogenous substance.

We realize that these investigations are still in the embryonic stage. They represent only the very first attempts, but, perhaps, in the right direction.

CONCLUSIONS

1. In case of typical thrombo-angiitis obliterans, conservative treatment should be resorted to before amputation.

The following sequence might be observed: (1) superheated air; best combined with (2) systematic hypodermoclysis of Ringer's solution. If these simpler conservative means prove of no avail, *conservative operative* measures are indicated, viz., (3) tying of the femoral vein or arteriovenous anastomosis.

Both latter methods should be subjected to further careful clinical research as to their *real* value.

2. Superheated air may bring improvement of the symptoms; however, a *lasting* beneficial effect therefrom has hardly ever been seen. It rarely controls the pain.

3. The systematic hypodermic injection of 400 to 500 c.c. of Ringer's (or of physiologic salt) solution (Mayesima-Koga) daily, or every second or third day, deserves a definite place in the conservative treatment of thrombo-angiitis obliterans. Its effect may be lasting or temporary. If temporary, repetition usually again brings improvement. Two such series of injections represent a sufficient test as to their usefulness.

4. If gangrene has set in, it can, of course, not be made good. What has died, remains dead. But its progress may be stayed by the hypodermoclysis treatment: old and obstinate ulcerations may heal; the otherwise uncontrollable pain can be relieved.

5. Internally, a simultaneous administration of organotherapeutic preparations deserves a careful test.

6. Inflammation of the wall of the blood-vessels of the next higher groups to the capillaries, arterial as well as venous, seems to be responsible for the thrombosis (Buerger). Its cause may be microbic.

However, the increased viscosity of the blood, viz., blood that is thicker than normal, also seems to play an important rôle in the etiology of the disease.

7. It is possible that an altered quality of the blood as such also represents a cause for the occurrence of the thrombosis and subsequent gangrene.

8. On basis of this reasoning, procedures which tend to reduce the coagulability of the blood *within the body* deserve to be tried in our efforts to find the underlying cause of the trouble.

9. Intravenous injections of anticoagulating substances, as, for instance, of a 2 per cent. watery solution of sodium citrate, may prove to be a useful adjuvant to the systematic hypodermic administration of Ringer's solution.

HYPOPHYSIAL DISORDER IN MAMMARY CANCER AND ITS RELATION TO DIABETES INSIPIDUS*

BY SHIGEKI SEKIGUCHI, M.D.

VOLUNTEER SCHOLAR IN THE MAYO FOUNDATION

CLINICIANS have known for some time that in cancer of the breast, especially in its last stages, polyuria appears for variable intervals without any recognizable cause. While the etiology of diabetes insipidus was still undetermined, polyuria in these cases was either overlooked, or was supposed to be a renal complication, such patients usually being of an advanced age, in which the kidney may frequently be found shrunken.

Diabetes insipidus has been divided into two groups: (1) The symptomatic, due to some organic brain disease (irritation of medulla, pons or cerebellum); (2) the idiopathic, which appears without any pathologic findings in organs and without any accompanying clinical symptoms.

The first condition has been already proved experimentally by many authors. As is well known, Claude Bernard observed that a transient glycosuria and polyuria could be provoked by puncture at a point in the floor of the fourth ventricle between the origin of the pneumogastric and auditory nerves. Eckardt repeated Bernard's experiment and found that the stimulation of a point just anterior to this so-called sugar centre would occasionally produce transient polyuria only. In addition, there are many clinical observations which favor the cerebral cause of polyuria. Kahler found affections of the infundibulum, substantia perforata posterior, and corpora mammillaria in 7 cases among 27 of diabetes insipidus. Oppenheim observed polyuria in 12 cases among 36 of basal luetic meningitis.

On the other hand, idiopathic diabetes is supposed by many authorities to be due to a disordered function of the kidney, and is not to be confused with polyuria in hysterio-psychopathic patients or that which is provoked by some emotional stress. Meyer thinks the cause of this disease is due to the inability of the kidney to produce urine, which exceeds a certain low grade of concentration. In these cases the lowering of the freezing point of the urine, the index of the concentration, shows little change after salty food. Forschbach and Weber¹

* This material was obtained and studied in the University of Tokyo.

observe, however, that the kidneys of such patients react in certain measure of the urine concentration not only to the supply of sodium chloride and purins, but to drugs which apparently must decrease the diuretic stimulus. As there is no pathologic finding in the kidney in this case, the source of the trouble is still questionable.

With advances in recent research of the internal secretory organs, the hypophysis cerebri has become a focus of investigation. Certain diseases, such as acromegaly, adiposogenital dystrophia, which are very likely to be caused by hypophysial disturbances, are often accompanied by diabetes insipidus. Borchardt reported a case of the hypophysial tumor, with polyuria and without acromegaly. Erdheim² observed the polyuria only in basophile adenoma of the hypophysis. Erdheim, Goetzel and von Bartals described the combination of adipositas, atrophy of the genitals, and diabetes insipidus. Later Frank³ and Cushing⁴ associated polyuria with bitemporal hemianopsia in lesions of the base of the skull with hypophysial disturbance. Indeed, Frank saw polyuria which was caused by a bullet in the region of the sella turcica. It is, moreover, known experimentally that polyuria is brought about by the extirpation of the hypophysis and almost invariably by resection of its pars posterior (Cushing and Goetsch⁵). Taking the above-mentioned facts into consideration, we must look for the real cause of polyuria in the pituitary body. At first Simmonds⁶ published the opinion, that diabetes insipidus in cancer of the breast was caused by metastasis into the hypophysis. His patient, a woman aged thirty-seven years, had her right breast removed for very extensive cancer, and afterwards had a recurrence in the breast and glands of the neck. Polyuria was noted about 8 weeks after the operation, and one month later the patient died. At autopsy the pars posterior of the pituitary body with the sella turcica was found to be completely destroyed by metastatic tumor, the pars anterior and intermedia remaining unchanged. Therefore, Simmonds thought the polyuria must be the result of the pars intermedia having been irritated to hyperfunction by the neighboring destructive process. He reported another case, however, with a different explanation. This patient was a woman forty-six years of age, in whom obstinate polyuria (7 litres daily) appeared nine months after the removal of her breast for cancer. She died three months later. In this case the total neurohypophysis, pars intermedia and pedicle were entirely broken down by the cancerous mass. From these findings, Simmonds did not think it possible that the polyuria was caused by the hypersecretion of the destroyed parts. On the contrary, he believed it the result of the loss of hypophysial

HYPOPHYSIAL DISORDER IN MAMMARY CANCER

function. Remembering that in the first case mentioned the pedicle, the probable channel of the hypophysial secretion, was destroyed by the metastatic tumor, he says the new explanation would be equally applicable.

Stimulated by Simmond's researches I investigated 35 hypophyses in cases of mammary cancer which came to autopsy. The original tumors in the breast were in all cases the glandular cell cancer. The pituitary body was divided into two unequal parts in the posterior anterior direction. The smaller part was cut by means of frozen section and stained by Sudan III and paracarmine for the special purpose of investigating the fat particles in the chromophilic cells of the pars anterior. The larger part was fixed by the Formol-Müller method, embedded with paraffin and cut in serial sections. The sections were stained with Delafield's hæmatoxylin and eosin, Van Gieson, and the combined stains of May-Grünwald and Pappenheim.†

By the last method, the nucleus is stained a splendid violet and the eosinophile a beautiful red. In the sections stained, I found two metastases in a series of 35 hypophyses. The histologic findings in the remaining cases were not abnormal, at least not abnormal enough to be worthy of mention. There are no peculiar variations in the different kinds of cells in the pars anterior. Sometimes the eosinophiles are relatively increased, sometimes chromophobes are greater in number. As is well known, the chromophiles, especially the eosinophiles, are in the majority in middle age and continue to increase with the advance of years. Löwenstein states that the chief cells are more numerous in the young than in the old. Thinking of these cells as probable different stages of secretion, no weight is attached to the slight variations of their relative number. Besides the fat metamorphosis of epithelium, the increase of pigment cells in the pars posterior seems to be due in advanced age rather to physiological changes. Benda found severe fatty degeneration of the epithelium in women of seventy-eight years of age, with cancer of the rectum, and thought it a sign of the marantic stage. Next the emigration of epithelial

† The use of the last stain is somewhat complicated, but advisable for the representation of cells of different kinds in the pars anterior. I shall describe it briefly: (1) The section is in May-Grünwald's stain, 30 minutes in an incubator at 37° C. (2) In diluted Panchrom solution (10 drops in 10 c.c.) stain, 30 minutes (in incubator). (3) Wash quickly in water. (4) Put in 2 per cent. picric acid solution. (5) Wash thoroughly with water. (6) Put in acetate of aluminum. (7) Wash in water then dry on blotting paper. (8) Dip quickly in alcohol and acetone. (9) Put in absolute alcohol until blue color of section becomes faint. (10) Put in cajuput oil and embed in neutral balsam.

cells in the pars posterior and the accumulation of squamous epithelial cells are considered senile signs (Naegeli⁷). First, Thom described such growth of cells of the pars anterior into the pars posterior. Löwenstein thought them chief cells, Erdheim considered them migratory basophilic cells and his opinion was confirmed by Rautman in animals. On the other hand, Tölken⁸ described them as the transformed cells of zona intermedia. These migratory cells cannot be confused with metastatic cancer cells, because the shape and size of the former and their nuclei are regular and almost similar, not only to each other but to the cells of the adjacent pars anterior, especially to the basophilic cells. The nucleus does not show karyokinesis nor is there any visible state of destruction or compression on neighboring parts. The accumulation of squamous epithelial cells was noticed first by Erdheim. They are found particularly on the anterior surface of the pars anterior, and more especially in the pedicle up to the infundibulum. The cells show no hornification and are not to be seen in young people. They are the embryologic remnant of the hypophysial duct, and become visible with advancing age. They can easily be distinguished by their localization and character from metastatic tumor cells. The following are brief descriptions of two of the more interesting cases.

CASE I.—H. A., a woman fifty-eight years of age. Simple mammary cancer. Two months after the removal of the right breast cancer recurred in the field of operation and spread to the left breast. The patient died 6 months later. During the last four weeks of her life polyuria associated with moderate polydipsia was present. The amount of urine varied from 5 to 9 litres and was of abnormally low specific gravity (1002–1005). Necropsy showed the wall of the chest, the ribs and several long bones affected with cancerous metastasis. The kidneys were not apparently diseased. No lesion was visible in the brain. The hypophysis cerebri weighed 72 cg. The anteroposterior diameter being 11 mm., transverse 15.5 mm., height 7 mm. Density was somewhat increased. The cut surface of the posterior lobe was gray. Frozen sections stained by Sudan III showed numerous fat particles in the chromophilic cells. In the fixed specimen the pars posterior was found almost completely occupied by a metastatic cancerous mass which extended to the borders of the pars anterior. The pars intermedia had many stiletted lumina filled with colloidal and desquamated cells. Cells of the pars anterior showed no remarkable variation. There was an excessive number of eosinophiles. The pedicle was free from metastasis.



FIG. 1.—Hypophyseal cavity in woman fifty-eight years old.

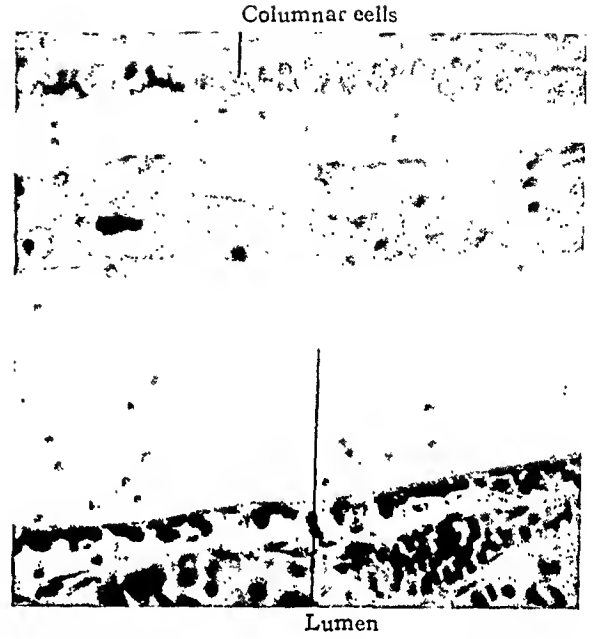


FIG. 2.—Columnar cells of the hypophyseal cavity.

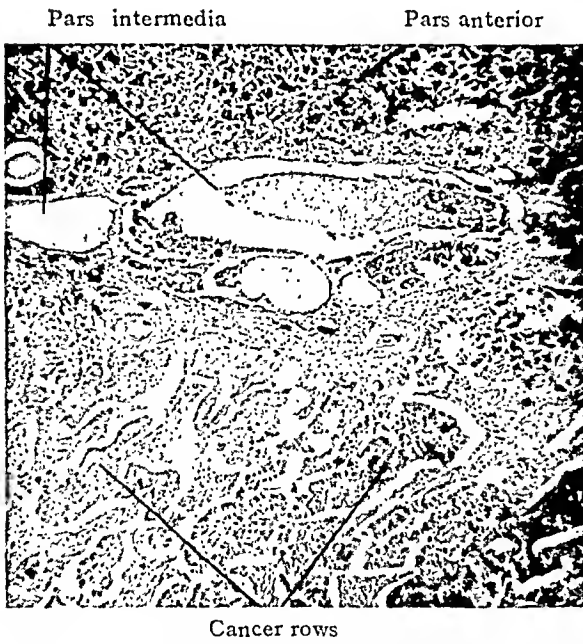


FIG. 3 —Case I. Metastasis of cancer in pars posterior of the hypophysis cerebri.

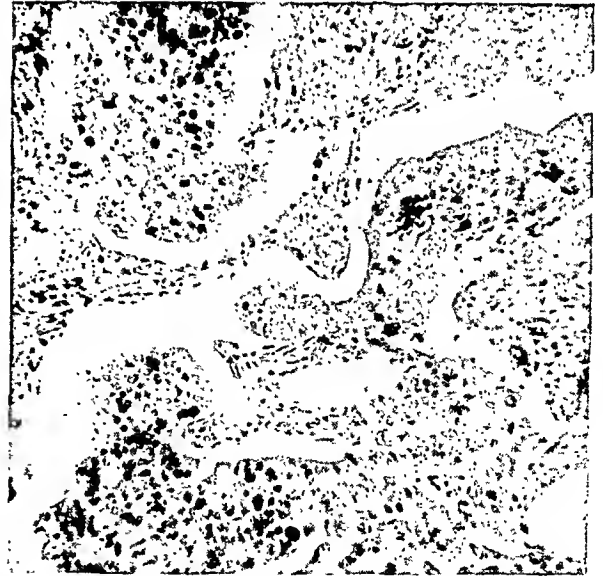


FIG. 4.—Case I. Cancer cells (200 mm.).

Emigrated cells



Pars posterior

FIG. 5.—Emigrated cells from pars anterior into pars posterior.



FIG. 6.—Emigrated cells from pars anterior (200 mm.).

Squamous cells

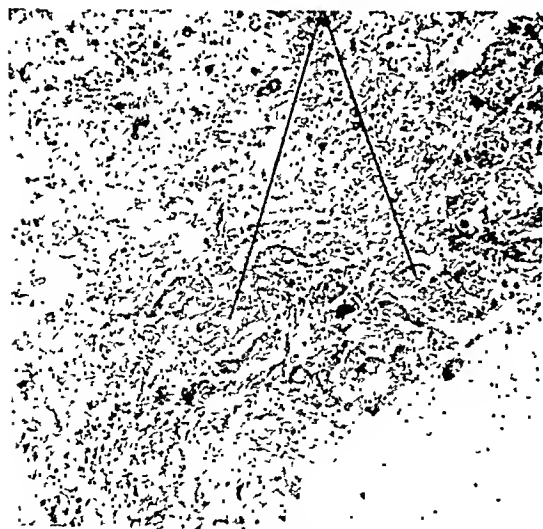


FIG. 7.—The accumulation of squamous epithelial cells.



FIG. 8.—Squamous epithelial cells (200 mm.).

HYPOPHYSIAL DISORDER IN MAMMARY CANCER

CASE II.—A. L., a woman forty-seven years of age. Right breast removed at operation. Histologic diagnosis was medullary cancer. About 5 months after the operation a metastatic growth appeared in the axilla and the supraclavicular fossa. Seven months after the operation the patient died. Several days before her death the quantity of urine increased 3 to 5 litres a day, with a specific gravity of 1003–1005. Necropsy showed part of the sternum affected by a cancerous mass which had broken into the mediastinum. In the right lung there were several small metastatic areas. The kidneys and brain showed no apparent pathologic changes. The hypophysis of normal consistence weighed 60.8 cg. Microscopically the pars anterior was not changed. The number of eosinophiles was relatively large. In the pars intermedia there were several dilated acini which were filled by colloidal masses. In the capsule and one part of the pars posterior near the pars intermedia there was a metastatic mass. That these were not the migratory cells of the pars anterior was evident from their character and also from the fact that the latter were compressed by the former. The pedicle was not affected.

Since there were remarkable changes only in the pituitary body, but not in the kidneys and brain, it seemed probable that in both my cases the hypophysial disturbance must have had some intimate relation to the polyuria. The fact of the pars anterior showing no pathologic change coincides with the opinions of many writers that it is probably concerned with the growth of the body but not with the production of urine. Experimental resection of the pars anterior confirms this opinion.

Concerning the next problem, namely, the function of the pars posterior, we have as yet no accurate knowledge. That the resection of the pars posterior usually causes polyuria has been confirmed experimentally. Cushing says, under certain operative conditions which entail manipulations of the posterior lobe, a diuretic response and occasionally an extreme polyuria often occurs. Schaefer⁹ observed that the subcutaneous implantation of the posterior lobe from one animal to another caused a temporary polyuria, which subsided in a few days, probably due to the absorption of the secondary product contained in the implanted tissue. Moreover, Schaefer and Herring¹⁰ found that pituitrin, the extract of the posterior lobe, effected the contraction of almost all blood-vessels, notwithstanding the dilatation of the renal vessels. They concluded, therefore, that the diuresis in these cases was caused neither by the elevation of general blood-pressure nor the hyperæmia of the kidneys, but only by the direct irritation of the epithelial elements of the kidneys. As the posterior

lobe consists chiefly of connective tissue and glia cells it is not likely to have intensive secretory function. Crowe, Cushing, and Homans¹¹ believe the cyst colloid of pars intermedia should be made active by the passage through the pars nervosa. Biedl says the effects of pituitrin must be brought back to the mixed extract of pars intermedia. Schaefer believes the effective secretion is produced in the pars intermedia and goes directly into the infundibulum, thence to the brain ventricle. Herring found in the loose tissue of the pedicle the hyaline body, which is the secreting mass of the pars intermedia. The pars intermedia seems to play an important part in hypophysial secretions, especially in diuresis. Schaefer and Herring believe there are two substances contained in hypophysial secretion, the one secretion transmitting, the other secretion checking, the former being usually in excess. This intermediate part of the hypophysis is modified from the embryonal hypophysial lobe and forms in the human adult many big or small cysts with the colloidal mass, which are covered with cuboidal or columnar epithelial cells (Stendell).¹² The appearance is very like the follicles of the thyroid. That this part is of much significance in secretion is easily guessed from its morphology. Both of my cases seem to demonstrate that the stimulation of this part can excite the diuretic function of kidneys. Therefore Schaefer's theory is sustained in these instances. But it seems very difficult to explain Simmonds's second case, which showed the complete destruction of pars posterior, intermedia and pedicle by the tumor. Considering polyuria as a result of deficient secretion of these parts, he mentioned the investigations of Farmi,¹³ Von der Velden,¹⁴ and Römer,¹⁵ in which the extract of the pars posterior and intermedia given by mouth or intravenously caused the reduction rather than the increase of urinal secretion. This latter explanation is of interest, provided he paid special attention to the pedicle. Of course, he described the pedicle as destroyed but it is important to ascertain if any of the pedicle was really there, because the hypophysial pedicle of the human being usually contains the same tissue as the pars intermedia and the latter may possess compensatory function.

On the other hand, Camus and Roussy¹⁶ recently reported experiments on dogs and other animals, the results of which seem to show that the hypophysis is not responsible for diabetes insipidus. The seat of mechanism regulating the water content of the organism seems to be in the region just behind the hypophysis in the gray matter of the third ventricle. These writers think that the experiments on record and clinical experiences apparently demonstrating the connection be-

HYPOPHYSIAL DISORDER IN MAMMARY CANCER

tween disorders of the pituitary body and diabetes insipidus have been misinterpreted; the inevitable concomitant injury of the region just to the rear of the hypophysis was probably the real cause of the diabetes. Notwithstanding, if we agree that the diabetes insipidus may have many factors in its etiology not wholly explained at present by hypophysial disturbances (Steiger),¹⁷ we may still believe that the secretion of the hypophysis, especially that of the pars intermedia, has some causal relation to the polyuria. Many reports of experiments and clinical observations exclude the concomitant injury to the neighboring brain. My two cases give some evidence to the latter opinion.

CONCLUSIONS

1. It is sometimes clinically noted that polyuria occurs in the last stage of cancer of the breast without any renal disorders.

2. In my two cases of cancer metastasis in the posterior lobe of the hypophysis were found no pathologic changes in the gray matter of the third ventricle.

3. My cases can be well understood by Schaefer's theory. The pars intermedia, compressed by tumor-mass in the pars posterior, developed a hypersecretory function and this secretion stimulated the epithelium of the kidneys to the overproduction of urine.

REFERENCES

- ¹ Forsbach and Weber: Beobachtungen über die Harn- und Salz-Ausscheidung im Diabetes insipidus. *Ztschr. f. klin. Med.*, 1911, lxxiii, 221-239.
- ² Erdheim, J.: Zur normalen und pathologischen Histologie der Glandula thyroidea, parathyroidea und Hypophysis. *Beitr. z. path. Anat. u. z. allg. Path.*, 1903, xxxiii, 158-234.
- ³ Frank, E.: Über Beziehungen der Hypophyse zum Diabetis insipidus. *Berl. klin. Wchnschr.*, 1912, i, 393-397.
- ⁴ Cushing, H.: Concerning the Symptomatic Differentiation Between Disorders of Two Lobes of the Pituitary Body. *Amer. Jour. Med. Sc.*, 1913, cxlv, 313-328. Concerning Diabetes Insipidus and the Polyuria of Hypophysial Origin. *Boston Med. and Surg. Jour.*, 1913, clxviii, 901-910.
- ⁵ Cushing, H., and Goetsch, E.: Concerning the Secretion of the Infundibular Lobe of the Pituitary Body and Its Presence in the Cerebrospinal Fluid. *Amer. Jour. Physiol.*, 1910-1911, xxvii, 60-86.
- ⁶ Simmonds, M.: Hypophysis and Diabetes Insipidus. *Münch. med. Wchnschr.*, 1913, i, 127-128. Über sekundäre Geschwülste des Hirnanhangs und ihre Beziehungen zum Diabetes insipidus. *Münch. med. Wchnschr.*, 1914, i, 180-181.
- ⁷ Naegeli, O.: Über die neueren Forschungen auf dem Gebiete der Physiologie und Pathologie der Hypophysis. *Inaug.-Diss.*, Freiburg, 1911.
- ⁸ Tölken, R.: Zur Pathologie der Hypophysis, *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1912, xxiv, 633-644.

- ⁹ Schaefer, E. A.: Die Funktionen des Gehirnanhangs (Hypophysis cerebri). Bern, Drechsel, 1911, 39 p. Croonian Lecture, the Functions of the Pituitary Body. Proc. Roy. Soc. Lond., 1909, lxxxii, 442-468.
- ¹⁰ Schaefer, E. A., and Herring, P. T.: The Action of Pituitary Extracts upon the Kidney. Phila. Tr. Lond., 1908, s. B., cxcix, 1-29.
- ¹¹ Crowe, S. J., Cushing, H., Homans, J.: Experimental Hypophysectomy. Bull. Johns Hopkins Hosp., 1910, xxi, 127-169.
- ¹² Stendell, W.: Zur vergleichenden Anatomie und Histologie der Hypophysis der Hypophysis cerebri. Arch. f. mikr. Anat., 1913, lxxxii, 1. Abt., 289-332.
- ¹³ Farmi, F.: Über Diabetes insipidus und Hypophysistherapie. Gaz. degli osped., 1913, Abst. Wien. klin. Wchnschr., 1913, xxvi, 1867.
- ¹⁴ Von der Velden, R.: Die Nierenwirkung von Hypophysenextrakten beim Menschen. Berl. klin. Wchnschr., 1913, ii, 2083-2086.
- ¹⁵ Römer, C.: Die Beziehungen zwischen der Funktion der Hypophysis cerebri und dem Diabetes insipidus. Deutsche med. Wchnschr., 1914, xl, 108-111.
- ¹⁶ Camus, J., and Roussy, G.: Diabète insipidie et polyurie hypophysaire; régulation de la teneur en eau l'organisme. Presse Méd., 1914, xxii, 517-521.
- ¹⁷ Steiger, O.: Über einen Fall von Diabetes insipidus und seine Beziehungen zur inneren Sekretion resp. zum erweiterten Vagussystem. Deutsche med. Wchnschr., 1912, ii, 1869-1872.

THE USE OF WARMED ETHER VAPOR FOR ANÆSTHESIA

BY FRANKLIN B. McCARTY, M.D.

AND

BENJAMIN FRANKLIN DAVIS, M.D.

(From the Department of Surgery of Rush Medical College)

THE purpose of this investigation was to determine whether ether vapor warmed to body temperature possessed any advantages over ether vapor as ordinarily administered. Some observers¹ have claimed that warmed vapor is less irritating to mucous membranes than unheated ether, that it is more effective as an anæsthetic, smaller quantities being required to maintain anæsthesia, and that its use preserves for the patient the energy which would otherwise be expended in heating cold vapor to body temperature. Others, however, maintain that warming of anæsthetic vapors is unnecessary² and their claim seems to have the tacit consent of surgeons generally, as the specially warmed vapors have been used in but few of the large clinics. Ether administered by the open drop method and vaporized by the inspired air has proven to be so satisfactory and so nearly without danger, when properly administered, that most surgeons hesitate to give it up without assurance that the new method will offer definite advantages.

There are four standard methods of administering ether, *i.e.*, closed ether, open or drop ether, intrapharyngeal insufflation and intratracheal insufflation. It became our problem to determine, first, the temperature at which unwarmed vapor is delivered to the patient by the various methods, the degree of warming which occurs in the air-passages, and the amount of energy used in so warming the vapor; second, to observe the effects of warmed and cold vapor on animals as regards the quantity of ether required to induce and maintain anæsthesia, local irritation, and the effect on body temperature.*

The apparatus used in determining the temperature of vaporized ether consisted of a tank so arranged that air from a foot bellows could be passed through the ether, over the surface of the ether, carried over the ether without coming into contact with it, or any combination of these routes; a mercury manometer attached to the outlet tube; a three-

* In these experiments dogs were used throughout.

ounce glass bottle fitted with an inlet and outlet tube and carrying a thermometer for recording the temperature of the vapor as it passed through. A constant pressure of 20 mm. of mercury was maintained, corresponding to an alveolar pressure of 1 to 2 mm., the amount required in intratracheal anæsthesia, and air was passed through the tank at a rate of 10,000 c.c. per minute—the amount used in normal respiration. The results of such an experiment are shown in Table I.

TABLE I

| | Start | 5 min. | 10 min. | 15 min. | 20 min. | 25 min. | 30 min. |
|---|-------|--------|---------|---------|---------|---------|---------|
| A. Temperature of vapor passed through ether (°C.)..... | 21° | 16.5° | 13° | 10° | 8.5° | 8.5° | 8.5° |
| B. Temperature of vapor passed over ether (°C.)..... | 22° | 17° | 14° | 12.5° | 12.2° | 12° | 12° |

Other observers ³ have recorded considerably less fall in temperature in similar experiments, the variation in results being due, probably, to the fact that they recorded the temperature of ether vapor discharged into a large capacity rubber bag. Such a bag is not generally used in administering ether vapor.

The vapor temperature in this series reached a minimum of 8.5° C. in most of the experiments, the time required to reach this varying with the percentage of ether vapor in the mixture. In some cases the temperature failed to go below 12° C. and it was found that such was the case on days in which atmospheric humidity was high (Table II).

TABLE II

| | Humidity | Temperature of ether vapor—°C. at | | | | | | |
|--|-----------|-----------------------------------|--------|---------|---------|---------|---------|---------|
| | | Start | 6 min. | 10 min. | 15 min. | 20 min. | 25 min. | 30 min. |
| | per cent. | | | | | | | |
| | 62 | 17° | 16° | 12° | 10.5° | 9° | 8.6° | 8.5° |
| | 81 | 21° | 15° | 12.5° | 14.5° | 11° | 11° | 11° |
| Air bubbled through water before being used to vaporize ether. | 100 | 18° | 17° | 15° | 14° | 13.8° | 12.5° | 13.5° |

With the idea of determining the most efficient method of producing warmed ether vapor, three ways were tried. The ether was first vaporized by passing through it a current of heated air. This was impractical because very hot air was required and, owing to the low boiling point of ether, there was danger of distilling ether into the receiving jar. When ether was warmed directly by immersing the tank in hot water

WARMED ETHER VAPOR FOR ANÆSTHESIA

the same held true. The method of heating the vaporized ether by passing it through a coil of tubing immersed in boiling water was found to be reliable and satisfactory.

In observing the effects of unwarmed vapor, the cone, intrapharyngeal, and intratracheal methods were used. With dogs it was not practical to follow the technic of the drop method as used in the Presbyterian Hospital and, in its place, the following scheme was adopted. A tin can, open at one end and with numerous perforations through the other, was taken. A few layers of gauze were placed in the bottom of the can, covering the perforations, and ether was dropped on the gauze through the openings. The open end of this improvised inhaler was fitted closely over the muzzle of the dog so that almost all of the air breathed passed through the gauze. The bulb of a thermometer was placed in the inhaler and a second one was inserted into the trachea through a tracheotomy incision. Care was taken to prevent the intratracheal bulb from coming into contact with the mucosa.

In the intrapharyngeal and intratracheal methods, the vapor was passed first through a glass jar containing a thermometer bulb to record the temperature at delivery to the patient, and from this it was passed into a catheter which was inserted, in the first instance, through the nares into the pharynx, and in the latter, through the mouth directly into the trachea. By placing a thermometer in the trachea or in the pharynx through a high tracheotomy incision, as the case might require, we were enabled to determine the temperature of the vapor at the point of delivery in pharynx or trachea, and, furthermore, since the temperature of the vapor before entering the mouth was known, it became possible to estimate the efficiency of the various parts of the respiratory tract as heating chambers.

As a check on this method the intubing catheter was carried out through a tracheotomy incision directly into a bottle which was provided with a thermometer and inlet and outlet tubes. As a further check lengths of tubing equivalent to those used intrapharyngeally or intratracheally were enclosed in an incubator at 37.5° C. and the change in temperature of the vapor recorded as it passed through this tubing at the same rate as it had been passed into the trachea. The degree of warming of the vapor corresponded closely in this artificial respiratory tract to that observed in the dog.

Before concluding the intratracheal experiments the main bronchus to the lower lobe of one lung was opened, a thermometer inserted and the temperature of the vapor at that level recorded. In the following

table the results of such an experiment are recorded (Table III). The temperature of the air-ether vapor mixture before delivery corresponded to that noted in Table I, *B*.

TABLE III

| | Start | 5 min. | 10 min. | 15 min. | 20 min. |
|--|-------|--------|---------|---------|---------|
| Inhalation cone—temperature in trachea (°C.) | 37.5° | 37.5° | 36.6° | 36.5° | 35.5° |
| Intrapharyngeal—temperature in mouth (°C.) | 17° | 17° | 17° | 17° | 17° |
| Intrapharyngeal—temperature in trachea (°C.) | 35° | 35° | 34.5° | 34.5° | 34.5° |
| Intratracheal—temperature in trachea (°C.) | 23.5° | 23.5° | 23.5° | 24° | 23.5° |
| Intratracheal—temperature in bronchus (°C.) | 33° | 33° | 33° | 33° | |

These findings seem to indicate that when ether is administered by inhalation, unwarmed, the vapor reaches the middle of the trachea at a temperature within one or two degrees of body temperature. In intrapharyngeal insufflation, where the warming effect of the mouth is partially lost, the temperature in the trachea is 3 or 4 degrees below body temperature. It is safe to assume, however, that in both instances the temperature is increased to that of the body before the vapor has passed through the primary bronchi. When the unheated vapor is delivered through a catheter inserted nearly to the tracheal bifurcation it is delivered considerably below body temperature, about 14° C., but of this deficiency 10° has been added by the time the primary bronchus has been passed so that the vapor unquestionably has been warmed to body temperature long before it reaches the alveoli.

Having determined the temperature at which the anæsthetic was delivered by the various methods and having determined that regardless of the temperature at which it enters the mouth the vapor is raised to body temperature before reaching the alveoli, two questions arose: Has the cold vapor any local injurious effect on the mucosa, and, is the amount of energy required to warm the vapor a serious tax upon the organism as a whole? The answer to the first question we attempted to find by comparing the local effects of warmed and unwarmed vapor and by observing the evidences of local irritation following anæsthesia. It was noted by direct observation of the trachea during the administration of cold vapor, and at autopsy, that there was a slight general injection with a moderate amount of mucus but no specially marked change opposite the outlet of the catheter. No difference was noted in the findings after warmed or unwarmed vapor and no difference could be noticed during convalescence. This agrees with the report of Meltzer,⁴ who regards the preliminary heating of ether vapor unnecessary for intratracheal anæsthesia.

WARMED ETHER VAPOR FOR ANÆSTHESIA

The second question we attempted to answer by inquiring whether warmed vapor is more actively anæsthetic and therefore effective in smaller quantities, and whether the amount of energy expended in warming the vapor is consequential in proportion to the quantity lost in other ways or to the total amount of energy in the body.

A series of dogs was anæsthetized by the intratracheal method, each dog being used twice, once with warmed and once with unwarmed vapor (Table IV).

TABLE IV

| | Times, Minutes | Total Ether, c.c. | Ether per minute, c.c. |
|--------------------------------|-------------------|----------------------|---------------------------|
| Unwarmed vapor throughout..... | 60 | 185 | 3.0 |
| Warmed vapor throughout..... | 70 | 225 | 3.2 |
| { Started with unwarmed..... | 30 | 125 | 4.6 |
| { Continued with warmed..... | 45 | 125 | 2.8 |
| { Started with warmed..... | 45 | 200 | 4.4 |
| { Continued with unwarmed..... | 45 | 120 | 2.6 |

No marked difference in the amount of ether required was observed and, after the first half or three-quarters of an hour, surgical anæsthesia by either method was maintained with approximately a 6 per cent. ether vapor—the concentration which was found necessary by Connell.⁵

In estimating the amount of energy required to warm cold ether vapor to 37.5° C. we assumed that the vapor was delivered at the lowest temperature, 8.5° C., which we were able to obtain and so had to be heated 29° C. The amount of heat in the body, assuming a weight of 150 pounds, is about 2100 cal., and the heat used up in 24 hours averages 2700 cal. at rest, or 3500 cal. at moderate work, a saving of 35 cal. per hour in the recumbent position. Of this heat loss a little less than 3 per cent. is used up in respiration, that is, in warming the air to body temperature and in the evaporation of water from the lungs. The loss of heat in breathing air at a temperature of 8.5° C. for one hour is 3.6 cal., the specific heat of air being 0.26, whereas the loss of heat in warming the same amount of air containing 6 per cent. ether vapor which has a specific heat of 1.025 is 3.95 cal., an increase of about one-third calorie per hour. The total energy required in heating air and ether vapor from 8.5° C. for one hour is about the equivalent of the energy expended in climbing 75 ft. of stairs. The amount of energy expended in breathing air in an operating room at 27° C. (80° F.) is 1.15 cal. per hour when no anæsthetic is used, so that the increased energy required to breathe ether-vapor-air mixture at its minimum temperature is about 2.83 cal. per hour.

The amount of heat lost in respiration is small when compared with the larger amount lost by radiation and conduction from the skin surface, the latter being 10 times as great under ordinary conditions, and much larger under the influence of anæsthesia when the peripheral blood-vessels are dilated and sweat-gland activity is increased. As a factor in saving energy it would seem that the use of a warm ether vapor was far less important than the prevention of excessive loss of heat by the skin. One can imagine poor operative risks in whom even the loss of 2.83 cal. might affect the outcome unfavorably. In such extreme cases it is questionable whether a general anæsthetic would be the anæsthetic of choice in any event.

Reichert⁶ has demonstrated that when dogs are thoroughly morphinized the rate of energy production, as measured by a calorimeter, may decrease 80 per cent. This is due largely to the inhibition of muscular and glandular activity. Similarly, when animals are subjected to a general anæsthetic, as a result of the more or less complete muscular relaxation and possibly some disturbance of the heat regulating centre, heat production decreases, the rate of heat dissipation influenced by the cutaneous vasodilation and sweat-gland activity probably increases, and the temperature falls. Theoretically the decrease in the rate of heat production, the increase in the rate of heat dissipation, and the fall in temperature should be proportional, roughly, to the depth and duration of the anæsthesia. One advocate⁷ of the practice of heating anæsthetic vapors, whose work has been quoted as proof positive of the correctness of the procedure, reported as follows: In a series of patients anæsthetized with unheated ether the fall in body temperature averaged $.57^{\circ}\text{C.}$; in a second series of patients anæsthetized with heated ether the average fall in temperature was $.18^{\circ}\text{C.}$ The refrigerating effect of the unheated ether was assumed to be responsible for an average decrease in temperature of $.39^{\circ}\text{C.}$ For a patient weighing 70 kilos this fall in temperature would be indicative, on the above hypothesis, of the loss of 27.3 calories—which is seven times as much as would actually be used in an hour's anæsthesia with the coldest air-ether vapor mixture obtainable with any apparatus now at hand for administering ether in anæsthesia. In a series of 20 dogs, 10 of which we anæsthetized for an hour with unheated ether and 10 with heated ether, the fall in temperature per pound was $.004^{\circ}\text{C.}$ greater for the dogs of the unheated ether group than for the others. If we had stopped with the eighteenth dog of the series our result would have been exactly the opposite. In other words, the factors which are difficult to control are so large and the difference between the influence of the unheated ether and the

WARMED ETHER VAPOR FOR ANÆSTHESIA

warmed ether is relatively so slight that only a very long series of minutely controlled animal or clinical experiments would be of any value in its determination.

CONCLUSIONS

1. The amount of heat required to warm ordinary ether vapor as used in anæsthesia by the open or closed methods, or by intrapharyngeal or intratracheal insufflation to body temperature, is so small as to be a negligible factor in lowering body temperature and inducing shock in anæsthetized patients.

2. The warming of ether vapor, however administered, is accomplished in the mouth, pharynx, trachea and primary bronchi, and the anæsthetic reaches the alveoli at body temperature.

3. The quantity of ether required to produce and maintain anæsthesia does not appear to be materially influenced by warming ether.

4. So-called cold ether vapor does not appear to be more irritating to mucous membranes than warmed ether.

5. No more mucus and saliva is secreted when anæsthesia is induced and maintained with cold than with warmed ether.

BIBLIOGRAPHY

- ¹ Coburn: *Med. Rec.*, N. Y., 1913, lxxxiii, p. 382.
- ² Seelig: *Interstate Med. J.*, 1911, xviii, p. 927.
- ³ Cotton and Boothby: *ANN. OF SURG.*, 1913, lvii, p. 43.
- ⁴ Meltzer: *Med. Rec.*, N. Y., 1910, lxxvii, p. 477.
- ⁵ Connell: *Surg., Gyn. and Obs.*, 1913, xvii, p. 246.
- ⁶ Reichert: *Philadelphia Med. J.*, 1901, vii, p. 474.
- ⁷ Davis: *Johns Hopkins Hosp. Bul.*, 1909, xx, p. 118.

TOLUOL

ITS ADVANTAGES OVER CHLOROFORM OR ALCOHOL AS A STORING FLUID FOR SURGICAL CATGUT

BY ALLEN ROGERS, PH.D.

OF BROOKLYN, N. Y.

IN CHARGE, INDUSTRIAL CHEMISTRY, PRATT INSTITUTE

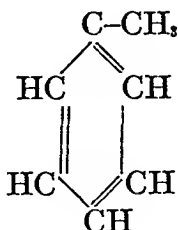
TOLUOL, $C_6H_5 CH_3$

Synonyms:

Toluene.

Methylbenzene.

Phenylmethane.



It is now generally conceded that the most dependable method of sterilizing catgut sutures is that originally proposed by Krönig, whereby the suture material, submerged in cumol, is subjected to a high degree of heat ($165^{\circ} C.$ — $329^{\circ} F.$).

Considerable difficulty, however, has heretofore been experienced in obtaining an entirely satisfactory medium for storing the sterilized suture materials in the tubes after their sterilization.

Cumol itself, while possessing superlative virtues as a medium for thermal sterilization, was found to be inadequate as a storing fluid, owing solely to its slow evaporation. On the other hand, its favorable qualities, namely, its high boiling point, stability, and absence of hygroscopic properties, were highly desirable.

In eliminating as many as possible of the sources of untoward surgical results, it has been found necessary to employ a storing fluid superior to chloroform for the following reasons:

First, chloroform breaks down under comparatively moderate heat into chlorine and hydrochloric acid, both of which exert an extremely harmful effect upon the gut.

Second, under the influence of sunlight, free chlorine, hydrochloric acid, and carbonyl chloride (phosgene) are liberated, the latter product in particular being extremely objectionable.

Third, the susceptibility of chloroform to deterioration from age.

Fourth, the inadequately low boiling point of chloroform.

Fifth, the very undesirable indurating or stiffening action which chloroform exerts on the collagen structure of the gut.

TOLUOL FOR SURGICAL CATGUT

Sixth, the disagreeably irritating effect of chloroform upon the tissues.

The chief difficulty in using alcohol as a storing fluid is the difficulty of freeing it from water and of maintaining its anhydrous condition.

Cumol, being a trimethyl substitution product of benzene, suggested the use of one of the simpler and more volatile methylbenzene compounds. Tests conducted with all of these demonstrated that the monomethyl substitution product of benzene, known as toluol, possessed the desired qualities.

Toluol is a light, colorless, bland, aromatic hydrocarbon of definite constitution, of the benzene series, boiling at 111° C. (231.8° F.), freezing at -93° C. (-135.4° F.), specific gravity 0.8723 at 15° C. Toluol is a very stable compound, not being decomposed by either heat, light, or age, as is chloroform. It was formerly derived from the dry distillation of the tolu balsam, but is now obtained on a much larger scale and in a state of greater purity from the distillation of coal-tar. It is very volatile, and has a pleasing and refreshing aromatic odor.

Unlike chloroform, toluol will not hold water in solution. This is a great advantage in the sterilization of catgut, as it is well known that the slightest degree of moisture tends to convert the collagen in the gut into gelatin, with the result that when the gut is subjected to thermal sterilization it becomes brittle, weakened, and twisted. Because of the composition of toluol there is no residue left upon evaporation, so that the sutures prepared with it will not be contaminated by foreign bodies. Toluol is a powerful solvent for oils and fats, and is therefore of great value in removing the irritant fats and fatty acids inherent to raw catgut. It clarifies the gut, imparting a transparency similar to that given by xylol in the preparation of histological sections.

Its softening influence upon the gut is quite marked when compared with the insufficiency of other oils and substances with which tests have heretofore been conducted.

Sutures stored in toluol when embedded in muscle, fascia, and peritoneum of animal and human subjects have been received kindly by the tissues, and have affected not in the slightest the period of convalescence.

Toluol itself when freely applied to superficial and deep wounds causes no irritating effects, either subjectively or objectively.

Toluol possesses a certain amount of germicidal ability, as found by T. H. C. Benians, M.R.C.S. (England), L.R.C.D. (London), Junior Assistant Inoculation Department, London Hospital. *Zeitschrift für*

Chemotherapie und verwandte Gebiete, Leipzig, 1913, Verlag von Georg Thieme. His conclusions stated as follows:

1. Toluol has no effect on spores and very little on the staphylococcal group of organisms.
2. It readily destroys all organisms of the Gram-negative class.
3. It has a marked action on the tubercle bacillus and on the diphtheria and many diphtheroid bacilli.
4. It has a moderately well marked destructive action on the streptococcal organisms.
5. Disintegration and lysis of bacteria in emulsions exposed to the action of toluol does not readily take place whether they have been killed by the toluol or have resisted its action.

ACUTE SECONDARY TUBERCULOUS SPLENOMEGALY: SPLENECTOMY

BY J. SHERMAN WIGHT, M.D.

OF BROOKLYN, NEW YORK

ASSOCIATE SURGEON TO THE LONG ISLAND COLLEGE HOSPITAL

R. C., eight years old, school boy, born in Italy, was referred to the Long Island College Hospital by Dr. Thomas.

Family History.—Father has arrested tuberculous lung disease and negative Wassermann. Mother has arrested tuberculous lung disease and + + + Wassermann. One brother and three sisters are well.

Past History.—December 16, 1913, operation for cervical adenitis left side of neck. Three months ago abscesses opened above left clavicle.

History of Present Condition.—One week after abscesses he had a slight chill, next day developed soreness on left side of abdomen. He had fever at night, his appetite was poor and he lost flesh. A tumor appeared below the ribs on the left side and grew rapidly.

Chief Complaint.—Pain and swelling just below the ribs on the left side.

Physical Examination.—Dusky pallor of the skin. Thin, anæmic, tongue coated, pulse accelerated, and temperature 102°. Head: Features coarse, lips thick, eyes normal, teeth separated and in fair condition, ears, mastoid, and thyroid negative, pharynx normal, tonsils enlarged, no palsies. Glands: Scar of operation on glands left side of neck, a few small glands on both sides of the neck. Chest: Non-active foci of tuberculosis in both lungs. Heart: Normal. Abdomen: Asymmetric, left upper quadrant was distended by an enlarged spleen. Peritoneum and other abdominal organs negative. X-ray (Fig. 1) shows large bronchial glands and diseased lungs. Kidneys normal. Blood examination: 3000 white blood-cells, 2,960,000 red blood-cells, 82 per cent. polymorphonuclears, 6 per cent. small lymphocytes, 4 per cent. lymphocytes, 8 per cent. transitionals, 65 per cent. hæmoglobin. Wassermann negative. Marked acidosis.

Literature.—Warren J. Collins, The Surgery of Spleen, ANN. SURG., 1910, xxxiii, 513-543, tuberculosis as an indication for splenectomy. H. Z. Griffin, Clinical Notes on Splenectomy, ANN. SURG., 1915, lxii, 166-172, one case of tuberculosis in list of splenectomies.

Decision to Operate.—Raised the question of general miliary tuberculosis, character of the organ involved, impossibility of surgically eradicating the disease, severe anæmia, and acidosis. Answered as follows: Disease arrested in lymphatic glands and lungs; miliary invasion in spleen only, therefore splenectomy would eradicate in same way as excision of glands. Spleen had lost its value as a blood-making organ. Acidosis could be controlled by intravenous injection of sodium hydroxide.

Preparation for Operation.—Hypodermic of morphine and atropine, 25 c.c. N/20 NaOH intravenous.

Operation (July 21, 1915).—Splenectomy under general and local anæsthesia.

Findings.—Enlarged diseased spleen. No adhesions. Other abdominal contents normal.

Procedure.—Spleen delivered through left Bevan incision, pedicle transfixed, vessels tied, and wound closed without drainage.

Specimen (Figs. 2 and 3).—Spleen weighed 950 grammes, it measured 19 cm. long, 9.5 cm. broad, 4.5 cm. thick, surface irregular and microscopical examination showed it filled with very young tubercles (see illustrations).

Clinical Course.—No shock. Temperature 104° that night; dropped to 99.1° next morning and remained near 100 for over two weeks. The wound healed *per primum*. July 24, blood examination, 5150 white blood-cells, 3,160,000 red blood-cells, 70 per cent. hæmoglobin. August 10, his temperature went up, he lost his appetite, the glands of his neck swelled, and he began to lose weight. He showed signs of active lung disease, he was sent to the roof to sleep out doors. He did not improve, so it was decided to transfuse him.

Decision to Transfuse.—September 13, the father's blood showed 4600 white blood-cells, 4,900,000 red blood-cells; hæmolysis, agglutinin, and precipitin tests with child's blood were negative. He was given 25 c.c. N/10 NaOH on September 13 and 14 to increase his leucocytes and counteract acidosis. September 15, father's blood, 8400 white blood-cells; September 15, child's blood, 8320 white blood-cells, 4,000,000 red blood-cells, 65 per cent. hæmoglobin. He was given 25 c.c. N/20 NaOH intravenously to neutralize acidosis. The father had arrested tuberculosis (see Fig. 4), so the question of tuberculous bacteræmia came up for consideration. It was decided that the father had educated leucocytes and specific antitoxin in his blood, since he was protecting himself. There was small chance of bacteræmia pointed out in the literature: *Schmidt Jahrbuch*, March, 1913, cccxvii, Hft. 2, 201. Tubercle Bacilli in the Blood, *Jour. Inf. Dis.*, 1914, xiv, 162.

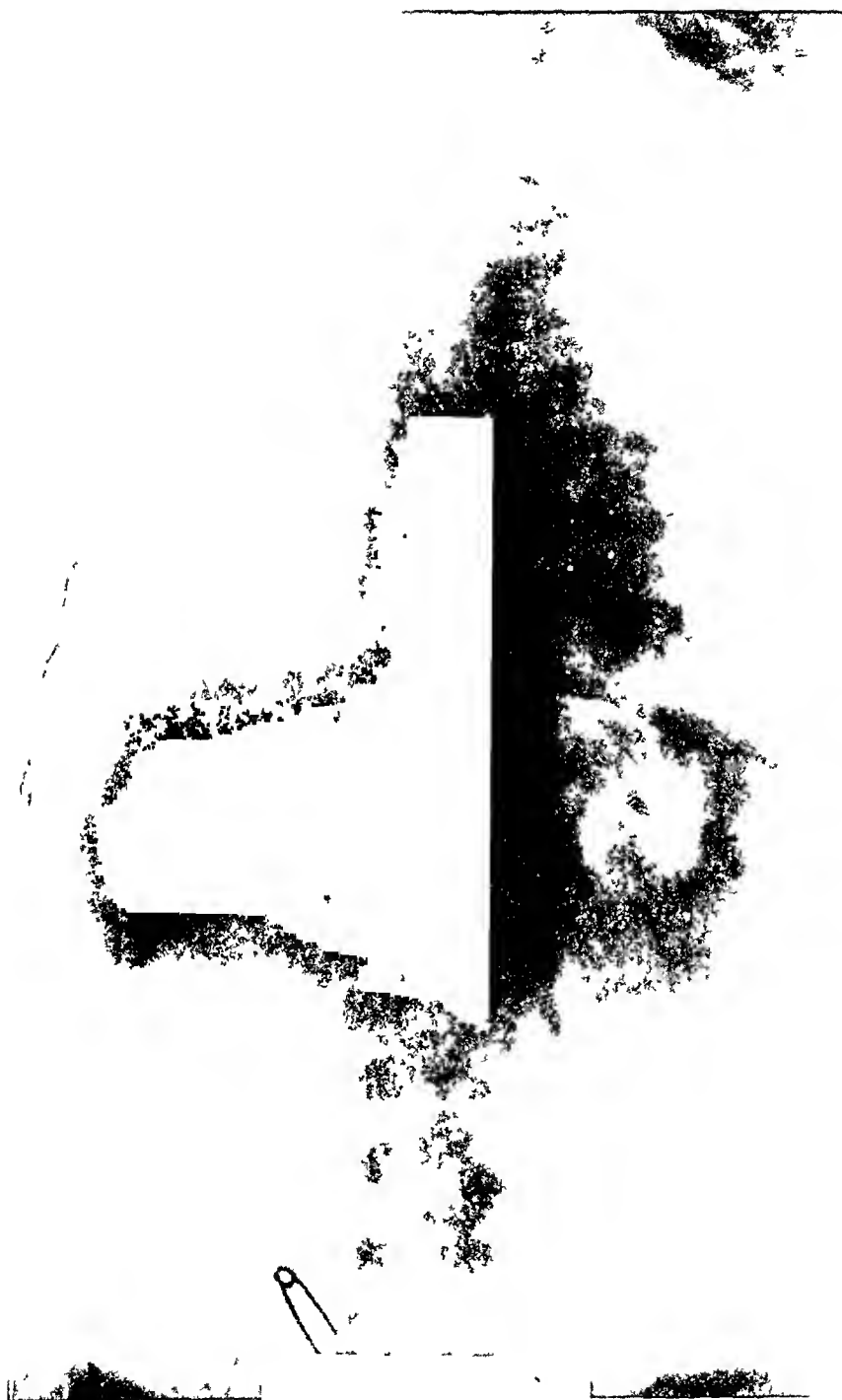


FIG. 1 —Röntgenogram of child's chest. Shows diseased lungs and large bronchial glands.



FIG. 2.—Photograph of gross section of diseased spleen removed. Shows convex surface and cut surface

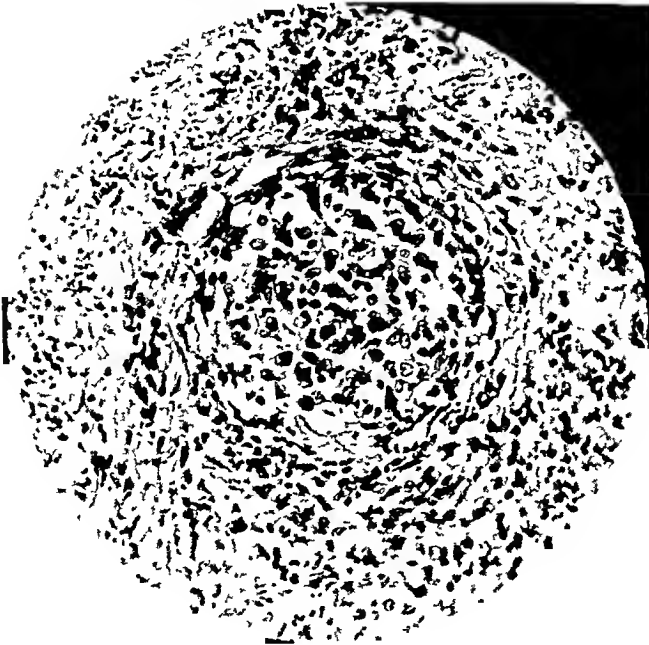


FIG. 3.—Microphotograph of tubercle from spleen.

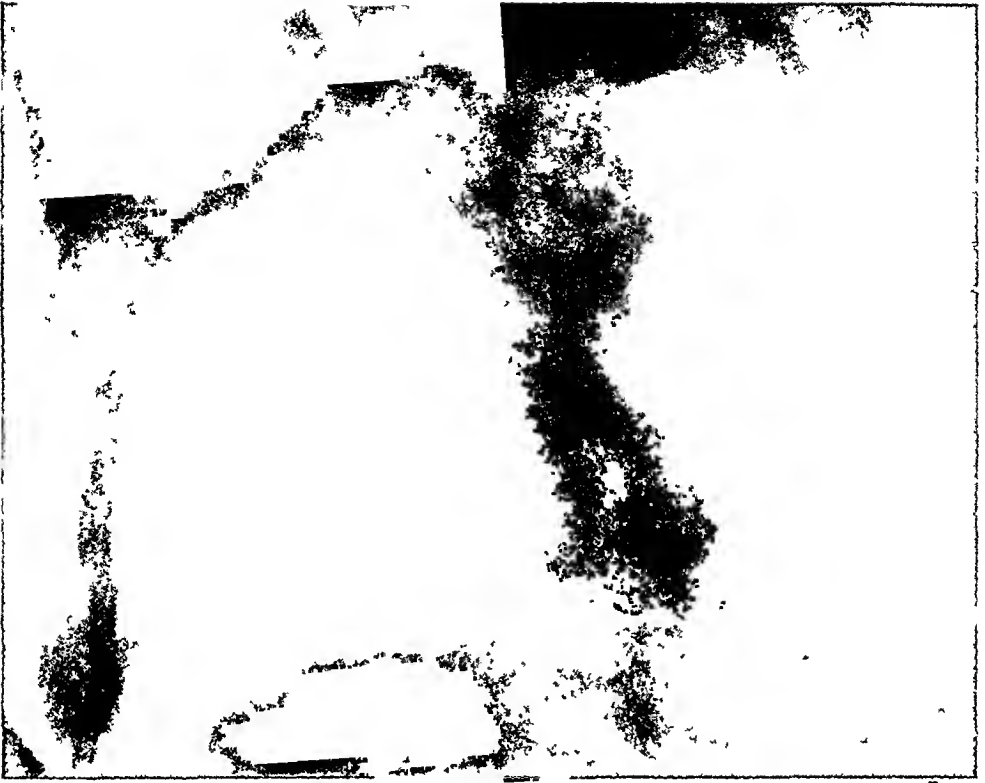


FIG. 4.—Röntgenogram of father's chest before transfusion. Shows arrested tuberculous disease of the lungs.

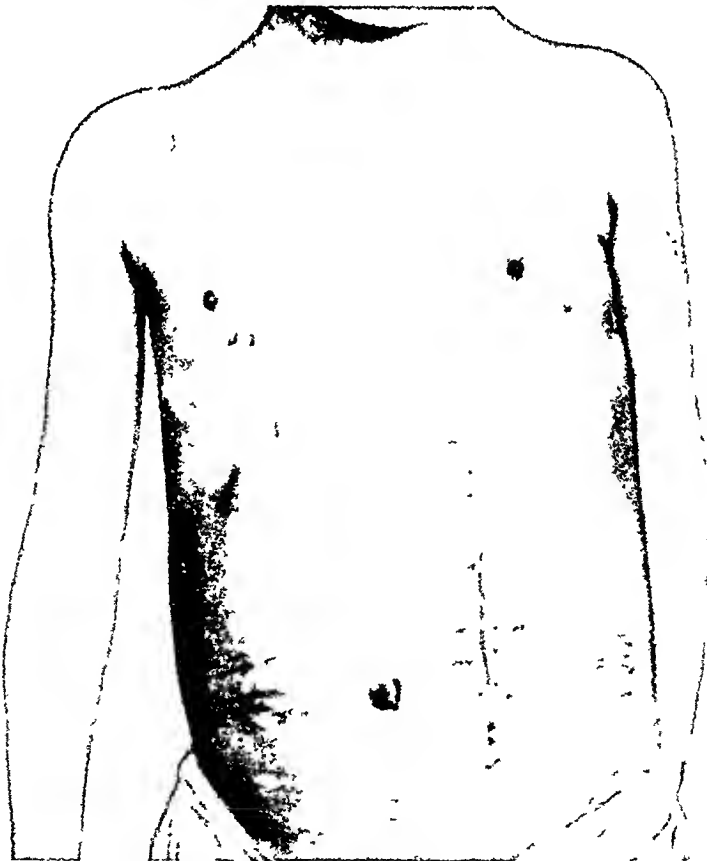


FIG. 5.—Photograph of child's abdomen after operation.

BEGIN ON OTHER SIDE OF SHEET

BEGIN ON THIS SIDE OF SHEET.

THE LONG ISLAND COLLEGE HOSPITAL

| Name | | Service of Dr. | | Hospital No. | | Name | |
|-------|------|----------------|------|--------------|------|------|------|
| DATE | 1920 | 21 | 22 | 23 | 24 | 25 | 26 |
| TIME | 7:00 | 7:15 | 7:30 | 7:45 | 8:00 | 8:15 | 8:30 |
| DAY | July | Aug | Aug | Aug | Aug | Aug | Aug |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| YEAR | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| DAY | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| MONTH | 1920 | 1920 | | | | | |

FIG. 6.—Temperature chart.

ACUTE SECONDARY TUBERCULOUS SPLENOMEGALY

Operation.—Lindermann transfusion, 200 c.c. hydroxylized blood from father.

Result.—Child's temperature dropped to normal within eight hours and remained lower. His weight increased and the swollen glands disappeared by October.

Theory.—Sodium hydroxide throws down protective substances from protecting cells and increases the number of leucocytes, therefore hydroxylized blood from an arrested tuberculous case would be a valuable specific antiproduet. It is an antacid, so neutralizes acidosis.

His temperature gradually rose and the glands in his neck began to swell the second week in October. He became worse, lost his appetite, and on October 29, developed a cultural diphtheria with a purulent discharge from his right nostril. He was transferred to the Contagious Disease Hospital. He developed dacryocystitis, became dull and stupid, showing profound toxæmia, and he died on November 14, 1915, with his lungs and glandular system thoroughly invaded with miliary tubercles.

Conclusions.—The tuberculous disease was not confined to the spleen and glands at the time the spleen was removed, so that procedure was futile in arresting the disease. The operation, however, was justified as it promised the only chance in the presence of such an overwhelming invasion. The transfusion should have been done immediately both before and after the operation to get the best benefit from immunity.

THE ANATOMICAL AND PHYSIOLOGICAL SUBDIVISIONS OF THE DUODENUM, WITH A NOTE UPON THE PATHOGENESIS OF ULCER

A PLEA FOR THE RATIONAL CLASSIFICATION OF DUODENAL LESIONS

BY GEOFFREY JEFFERSON, M.S. (LOND.), F.R.C.S. (ENG.)

AND

GERTRUDE FLUMERFELT, M.R.C.S. (ENG.), L.R.C.P. (LOND.)

OF VICTORIA, B. C.

The Anatomical and Physiological Subdivisions of the Duodenum, and the Classification of Duodenal Lesions.—It is not until we come to consider problems of normal and of abnormal physiology that anatomical boundaries are put to the test and flaws sometimes discovered. The subdivisions of the duodenum as commonly given in anatomical textbooks are very artificial and are neither physiological nor embryological. The use of these subdivisions as the basis of classification of duodenal lesions leads to misunderstanding and inaccuracy, and at the same time obscures the proper interpretation of the diseases to which this part of the alimentary tract is subject.

The Subdivisions of the Duodenum According to Academic Anatomy.—The duodenum forms the first twenty-seven centimetres or so of the small intestine, from which last it differs more because of its fixation to the posterior abdominal wall, than because of any extreme peculiarity of structure. Its fixation is not so great but that it can glide upward and downward as a whole during the movements of respiration.¹ The only portion to be completely peritonealized is the first inch. The duodenum does not lie in the same plane in its whole length, the descending portion being in the sagittal plane, almost at right angles to the rest of its course. The usual anatomical description of the duodenum divides it into three² or four parts, or alternately into superior, descending, horizontal, and ascending limbs.³ The first part ends at the neck of the gall-bladder,^a the second or

^a The downward bend which the duodenum takes at this point, the superior duodenal flexure or angle, is sometimes used as an additional divisional mark. There are two disadvantages in this for the surgical pathologist: (1) The angle involves over an inch of gut and hence is not a very exact delimiting point. (2) Cicatricial contraction of the bowel wall may flatten out the angle altogether.

descending portion terminates at the inferior duodenal angle (opposite the fourth lumbar vertebra), where the gut bends upward and to the left to enter on its third portion, which extends to the duodenojejunal flexure. The bile-papilla (papilla major Santorini) is situated a little proximal to the centre of the descending or second part. It is a remarkable fact that the papilla has not been used as a divisional mark, save by one or two clinicians, since such a division would be not only convenient but embryologically correct. For from the developmental side the duodenum is divisible into two parts, the dividing line being at the papilla major Santorini. The cephalad part arises from the foregut in common with the stomach and part of the oesophagus, whilst the caudad part, with the small intestine proper, is a derivative of the midgut. From this point of view it may be argued that the duodenum stretches from the pylorus to the bile-papilla and that the remainder is plain small intestine. This was suggested by Glisson⁴ but the proposal found no favor with academic anatomy, which extended the limits of the duodenum, first to the point of crossing of the superior mesenteric vessels, later to the flexura duodenojejunalis. To this day there is dispute as to what point constitutes the proper termination of this loop of gut, for Villemain⁵ in 1911 and again in 1913 drew attention to the fact that the true duodenal structure is lost at a point 1 to 3 centimetres proximal to the duodenojejunal flexure. This question has a certain academic interest, for if Villemain is right neoplasms of the flexura, two examples of which are mentioned by Mayo,⁶ belong to the jejunum, and not to the duodenum.

It is important to remember that the duodenum is given a separate name in contradistinction to the rest of the small intestine not because of any extreme peculiarity of origin or structure,^b but mainly because it forms a loop which is fixed to the posterior abdominal wall and largely unperitonealized in contrast to the mobile lengths which follow. It is obvious that until the fetal intestine has rotated and become fixed no duodenum (as we see it in the adult) exists, though it is usual to regard as such the small portion of intestine proximal to the papilla.^c

The object of these remarks is to show that the duodenum as a cephalad and caudad to the bile-papilla (papilla major Santorini), is

^b It is true that the duodenal wall contains Brunner's glands whose acini penetrate the muscularis mucosæ. They are very numerous above the papilla, but become more sparse below this point and disappear altogether proximal to the flexura duodenojejunalis.

^c See, however, a new account of the development and fixation of the duodenum—Frazer and Robbins, *On the Factors Concerned in Causing Rotation of the Intestines in Man*. Jour. Anat. and Phys., October, 1915.

whole is a more or less artificial subdivision of the intestinal tract, and that anatomy has paid more attention to peritonealization than to embryology. There is much justice and convenience in keeping intact under one name this fixed loop of gut, but it is unfortunate that the bile-papilla has not been used as a divisional mark, as it is the only logical boundary which this portion of the alimentary canal contains. The present limit between the first and second portions is singularly unfortunate, for it does not depend on any flexure or alteration in the wall of the bowel but upon the contiguity of the latter to the neck of the gall-bladder—an extrinsic, deep, and far from immobile mark. This is disadvantageous to pathology, for disease processes are very apt to distort normal relationships; Moynihan remarks the difficulty of deciding whether an ulcer lies in the first or in the second part.⁷ It is very doubtful whether the statistics of duodenal ulcer are at all trustworthy on this point, as a search of the literature has taught us.

Discontent with Existing Subdivisions.—Dissatisfaction with the ordinary descriptions and divisions of the duodenum has been expressed from time to time (see Jonnesco, Charpy and Dieulafé, p. 284, *loc. cit.*) and has been revived lately by both surgeons^{8, 9} and radiographers.^{1, 10} These have focussed their attention on the proximal or juxtapyloric portion and have emphasized its special liability to ulcer and its characteristic X-ray appearances. Holzkecht has called it the “bulbus duodeni”; Cole, “the cap or pilleus ventriculi.” Unfortunately these observers have not contented themselves with a declaration of the independence of this part of the small intestine, but have sought to include it in the stomach. None of the arguments for such a procedure so far advanced will bear close critical investigation. Much has been made of the common origin from the foregut of the stomach and proximal duodenum. If this is a valid reason for including the duodenum in the stomach, the inclusion of the lower part of the œsophagus might be demanded with equal logic. The œsophagus and stomach are physiological entities of determinate extent and this is equally, though not so obviously, true of the duodenum.

As already mentioned, the proximal duodenum is derived from the primitive foregut which ends at the bile-papilla. Here the liver and pancreas budded off. The duodenum below this arises from the midgut in common with the rest of the small intestine. It seems to us that the different embryological origin of the two parts of the duodenum, cephalad and caudad to the bile-papilla (papilla major Santorini), is best employed in emphasizing the individuality of the two moieties of this part of the digestive tube. The emphasis of individuality must

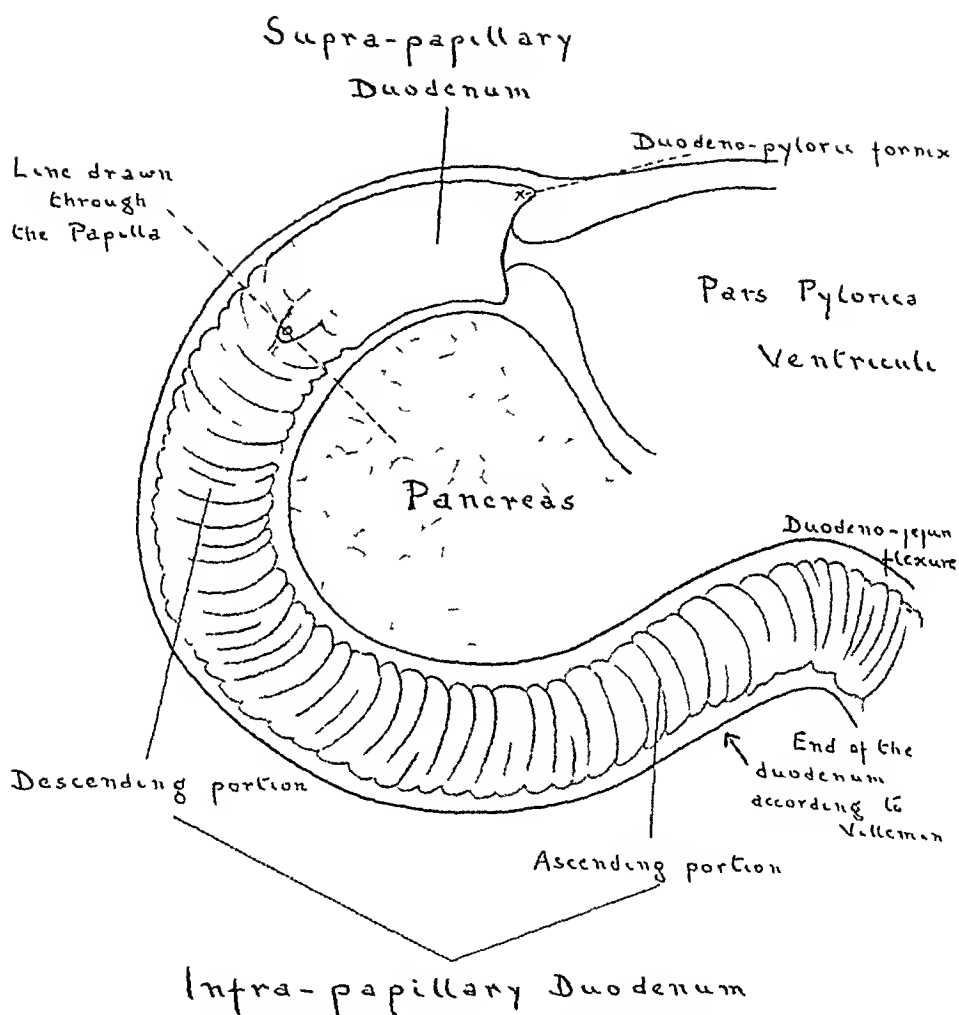


FIG. 1.—Schema of the proposed division of the duodenum by a line passing through the bile papilla. The proximal (cephalad) portion is the suprapapillary duodenum, the distal (caudad) the infrapapillary

not be too strong, for we are all the time accumulating evidence of the physiological unity of the whole gastro-intestinal tract (see for example the recent illuminating work of Alvarez¹¹ and of Keith).²⁶ Another serious drawback in the method of partitioning of the duodenum at present in vogue is that it is impossible to tell from ordinary pathological records what was the relationship to the papilla of any given lesion, unless this is separately and specifically stated. To say that a lesion is in the second part of the duodenum is to give no information at all as to whether it is above, below, at, or alongside the bile-papilla. Such information may be of considerable value (*vide infra*).

Anatomical Division of the Duodenum with an Embryological and Physiological Basis.—The only easily recognizable landmarks of this portion of the alimentary canal are: Its commencement at the duodenopyloric junction, its termination at the duodenojejunal flexure and the point of entrance of the bile and pancreatic ducts at the biliary papilla. At this latter point also the mucous membrane undergoes a change from a condition of fine “chagrination” to become arranged in crescents and spirals—the plicæ circulares (Kirkringi) or valvulae conniventes. The entrance of the bile and pancreatic ducts is not only the great event of the duodenum, but it is the only obvious orientating mark for subdivision. A division of the duodenum by a line drawn through the bile papilla meets the requirements of embryology and leaves nothing to be desired in the classification of lesions of this part.

We shall therefore divide the duodenum into two parts, cephalad and caudad to the bile papilla (major Santorini). The portion above this point will be called the “suprapapillary portion,” that below the “infrapapillary portion” (see Fig. 1). These two parts are of unequal length, the latter being about twice as long as the former. The suprapapillary portion though short is of considerably more surgical importance than the lower part. Not only is it the favorite haunt of chronic ulcer, but it is rich in pancreatic rests¹² and is sometimes the site of diverticula.¹³ The infrapapillary portion includes as much of the second or descending part of the duodenum as lies below (caudad to) the bile papilla, and the whole of the ascending part as far as duodenojejunal flexure. If, therefore, it is thought that it is not accurate enough to say simply that a lesion lies in the infrapapillary duodenum, one can qualify this by remarking

^d Some authors would probably divide the infrapapillary duodenum into three parts: a descending, a horizontal, and an ascending part. The horizontal part is not always present. It is best seen in the U-shaped duodenum, less well in the C-shaped form (figured), and not at all in the V-form.

that it lies in the descending or in the ascending limb^d of this division, so many centimetres from the papilla. There is nothing original in the suggested division of this fixed part of the alimentary canal. It has already been urged by Boas¹⁴ and apparently also by Sherren,¹⁵ chiefly for the classification of tumors. It is equally valuable for the grouping of ulcers, but it has not been accepted by English and American surgeons in general, owing, we feel sure, to an imperfect realization of the great superiority which this method has. It has one great advantage over the method of subdivision at present in vogue, and that is, that the dividing mark is an intrinsic anatomical feature in the wall of gut. This is a very important point, for nothing could be more difficult than to decide whether a given ulcer lies in the first or in the second part of the duodenum when the distinction depends on the relationship of the ulcer to the neck of the gall-bladder (which may be buried in adhesions).

A warning here as to nomenclature: The old term "first part of the duodenum" is not synonymous with the new one of "suprapapillary duodenum," for the latter includes the former and as much of the second part, besides, as lies above (cephalad to) the bile-papilla.

The duodenum has different physiological purposes in its different parts. The suprapapillary part is intimately concerned with the closing and opening of the pylorus, though other parts seem to be involved in this as well (Alvarez,¹¹ p. 390). There is also a difference of chemical reaction, for the first few centimetres of intestine are the only parts which have an acid reaction normally (Moore and Bergin).¹⁰ ^c It is very tempting to suppose that this explains the very high incidence of duodenal ulcer in the suprapapillary portion, whilst the alkalinity below the papilla accounts for the rarity of peptic ulcer there. To obtain evidence of this from existing statistics entails a rearrangement of these upon our new basis.

The Incidence of Duodenal Ulcer in the Light of the New Classification.—Moynihan, the Mayos, and Patterson agree that the vast majority of duodenal ulcers occur in the first three-quarters to one and a half inches of the duodenum, *i.e.*, well within the limits of the acid suprapapillary portion. They do not, however, give their own case figures as to the incidence of the lesion in the different parts of the duodenum, except that Moynihan says that 95 per cent. of his cases occur in the first part. One of us has been through Moynihan's

^c There seems to be some doubt on this point. But, possibly, if the rest of the intestine is sometimes acid it may be an organic acidity as opposed to an inorganic acidity near the pylorus.

SUBDIVISIONS OF THE DUODENUM

cases (Detailed Statement of Cases Operated Upon, p. 317, *loc. cit.*) The situation of the ulcer is definitely stated in 224 cases (counting actual ulcers and indurations, but not adhesions without definite ulcer). In no single case of all these was the ulcer below the papilla. It was near it in one or two only, and in one case (No. 180) jaundice was caused by adhesions to the common bile duct as it disappeared behind the upper margin of the duodenum. In all of 224 cases, the ulcer was suprapapillary. A similar examination of Perry and Shaw's cases¹⁷ was made. Their statistics have been very widely quoted, by almost every one, in fact, who has written on duodenal ulcer. They state that of 149 ulcers, 123 were in the first part, 16 in the second, and only 2 in the third. These figures bring out, they say, two facts: That ulcers are practically confined to the portion above the biliary papilla, and that they are eight times more numerous in the first than in the second part. In going over their cases (which are all recorded in some detail) we have found that there were only two definitely infrapapillary ulcers; one was tuberculous (Case 66), the other uræmic (Case 151). Three ulcers were situated at the papilla itself (Cases 89, 141, 221). The remainder, 115 in number,^f were all suprapapillary. Of more recent statistics, Peck¹⁸ states that only 1 out of 71 ulcers was in the second part of the duodenum and this one was apparently suprapapillary. There are also 41 suprapapillary cases of Wilkie's²⁰ and 25 of Codman's.³¹ This is not to say that ulcers are never found distal to the papilla, though they are certainly very uncommon there and authentic examples are few. Such an one is a case of Hartmann's recorded at length by Houdard.³⁰ A gastro-enterostomy was performed for pyloric ulcer; the patient died and at autopsy the ascending portion of the infrapapillary duodenum was found to be almost completely occluded by a second ulcer. The remaining 16 cases of Hartmann's series were all above the papilla.

^f Note by G. J.: Perry and Shaw (writing in 1893) used a peculiar classification—"duodenal ulcers associated with tuberculosis," "typhoid ulcers of the duodenum," "anthrax," "septic ulceration of the duodenum," "burns," "Bright's disease," and so on. It is evident that their valuable work includes duodenal ulcers of every conceivable etiology, but this fact precludes the use of their statistics as they stand in a discussion of the ordinary duodenal ulcer as we know it to-day. I have therefore gone over their cases and have been able to collect 118 examples of ordinary duodenal ulcer, not including in this figure tuberculous or uræmic ulcers, nor those due to poisons, nor to anthrax, nor to the bacillus typhosus. I have used these 118 cases as the partial basis of certain remarks above, believing them to be purer examples (as it were) than the 149 which Perry and Shaw have used for their statistics. Of the 118 cases, 115 were suprapapillary, and 3 papillary. None were infrapapillary.

Taking Moynihan's 224, Perry and Shaw's 118, Peck's 71, Wilkie's 41, Codman's 25, and Hartmann's 17 cases together, we have a total of 496 peptic duodenal ulcers in which the precise relationship of the lesion to the papilla is known. Of this number 492 were suprapapillary, 3 were papillary, and there was one infrapapillary ulcer.

We may therefore be justified in the following conclusions:

1. That the ordinary peptic ulcer of the duodenum has its site of election in the acid suprapapillary region.
2. That it decreases in frequency as the bile-papilla is approached.
3. That whilst it is rare at the papilla itself,
4. It is very uncommon in the infrapapillary portion of the duodenum.

The Probable Pathogenesis of Duodenal Ulcer.—The decreasing incidence of duodenal ulcer as the distance from the pylorus is increased is a very striking fact. The more so since the fundamental pathogenesis of this lesion seems to be a question of chemistry—of acidities and alkalinities. Something more than a mere acidity of some 0.2 per cent. is, of course, necessary to produce an ulcer here as elsewhere, but one of the first facts which was noted about these so-called "peptic ulcers" was their distribution in that part of the digestive tube to which the gastric juice has access in an unneutralized condition. Bolton¹⁹ has made observations upon the rôle of the hydrochloric acid of the gastric juice in the causation of experimental ulcers. He has shown that if the gastric juice is kept neutralized artificially, ulcers do not occur. We know further that simple peptic ulcer in the jejunum is unknown until we let the acid gastric contents into it by a short-circuiting operation, though here again something more is usually needed before an ulcer will develop—in this case an indigestible piece of silk or linen thread (see an account of 125 collected cases, Marquis).²⁰

An interesting case of peptic ulcer in the ileum has recently been published by Callender.²¹ It lay in a Meckel's diverticulum, but this was lined with gastric glands of the fundic or acid-secreting type.

The reaction of the duodenum below the papilla during digestion must be strongly alkaline. Contrary to general belief, the duodenum exhibits very great activity, in its infrapapillary portion at least (Alvarez²²), sweeping its contents on and not lying flaccid and inert as so many have supposed.

The experiments of Steinharter²³ and Rosenow²⁴ tend to show that bacteria play an important part in the production of ulcers. But something more still is needed before the experimentally produced

SUBDIVISIONS OF THE DUODENUM

acute ulcer will consent to become chronic. This third factor seems to be stasis. Bolton¹⁹ believed that he could prevent his acute ulcers in animals from healing if he could cause delayed emptying of the stomach. Friedmann and Hamburger²⁵ have apparently succeeded in doing this, with the result that Bolton anticipated. Delay in the emptying of the stomach and delay in the passage of food through the duodenum can be produced by changes in the intestine at a distance (see Alvarez,¹¹ foot-notes, etc.). It seems to us very probable that a chronic appendicitis, the coexistence of which with gastric and duodenal ulcers has frequently been commented on, might not only supply the bacteria necessary, but might also cause the needed stasis by reflex action.

The Classification of Duodenal Neoplasms, with Special Reference to Their Situation.—For the classification of duodenal neoplasms the excellence of the nomenclature and method described above is more obvious. It has not been widely used, however, in spite of this. Rolleston,²⁷ for instance, has given the sites of duodenal carcinomata in 51 instances. The first part was affected alone in 8 cases, and together with the second part in 7 more; the second part was involved alone in 29 cases, and together with the first in 7, as just remarked; the third portion was the site of 4 growths, and together with the second in 1 more. In the light of modern knowledge of the close relationship which exists between carcinoma and preëxisting simple chronic ulceration, these statistics are rather surprising. For the second part, which is not commonly the site of ulcer, has by far the largest number of cancers. As they stand, however, the figures quoted do not tell the truth of duodenal cancer. When we speak of duodenal carcinoma we mean, or should mean, a carcinoma which has sprung from the mucous membrane which lines the duodenum. Now a very large number of cancers involving the second part of the duodenum have sprung from the ampulla Vateri or the two ducts which unite to form it, as Rolleston himself admits, and not from the duodenum proper at all.

If these tumors of the biliary tract are subtracted from the total of those occurring in the second part of the duodenum, very few remain.⁸ It is difficult to regroup Rolleston's collected cases on the "papillary" basis. A provisional grouping would be: Suprapapillary, 15+; infrapapillary, 5+; the plus sign representing the unknown num-

⁸ Rolleston elsewhere²⁸ speaks of having notes of 19 cases of ampullary cancer. If these are all included in his 29 duodenal cancers of the second part, abstraction of these leaves 10 true duodenal tumors, *i.e.*, less than the first part total, but more than the third.

ber of true duodenal cancers of the second part (10 perhaps should be divided between the two groups; see foot-note).

Of 10 cases of duodenal cancer described by Perry and Shaw (*loc. cit.*) in their exhaustive paper, 6 were suprapapillary, 2 papillary and 2 infrapapillary, figures which bear out the regrouping above. These 10 cases of Perry and Shaw are probably included in Rolleston's 51 cases. Rolleston further states that three-quarters of the carcinomata of the small intestines originate in the duodenum. We do not think that this is so, if we limit ourselves to true duodenal tumors. It is doubtful whether carcinoma is commoner in the duodenum than elsewhere in the small intestine, save perhaps in the suprapapillary portion where the liability to chronic ulcer increases the possibility of malignant metaplasia. Cancer following duodenal ulcer is notably rare. We have so far been able to find only about 25 examples in literature.

SUMMARY

1. The ordinary subdivisions of the duodenum as given in anatomical text-books are neither embryological nor physiological.

2. The duodenum is best divided into two parts cephalad and caudad to the bile-papilla. These parts are conveniently called "supra-" and "infrapapillary." This is not only developmentally correct, but stands the test of pathology.

3. An examination of certain statistics of duodenal ulcers shows that they are very common in the acid suprapapillary region; that their incidence decreases as the papilla is neared, and that they are extremely rare in the alkaline infrapapillary region. The normal physiological differences of these parts above and below the papilla is thus emphasized by pathology.

4. Statistics allege that duodenal carcinoma is commonest in the second part. This is fallacious and is due to the inclusion of Vaterian cancers in the total of duodenal neoplasms. When these have been subtracted carcinoma seems to be commoner in the suprapapillary region than in the infrapapillary part, possibly because of the greater incidence of chronic ulceration in the former.

REFERENCES

- ¹ Lippman, C. W.: The Duodenum: A Röntgen Study. *Surgery, Gynecology and Obstetrics*, xix, 1914, p. 724.
- ² Waterston, D.: The Digestive System. *Cunningham's Text-book of Anatomy*, 4th Ed., London, 1913.
- ³ Jonnesco, Charpy and Dieulafoy: Duodénum. *Traité d'anatomie humaine*. Poirier and Charpy, vol. iv, fasc. 1, 1912.
- ⁴ Glisson: Quoted by Jonnesco, Charpy and Dieulafoy.

SUBDIVISIONS OF THE DUODENUM

- ⁵ Villemin, F.: Lower Limit of the Duodenum. *Lancet*, Lond., 1913, vol. ii, p. 543.
- ⁶ Mayo, W. J.: Operative Results in Carcinoma of the Gastro-intestinal Tract. *Mayo Clinic Papers*, 1912.
- ⁷ Moynihan, Sir Berkeley: *Duodenal Ulcer*. 2nd Ed., London, 1912.
- ⁸ Mayo, W. J.: Ulcer of the Duodenum. *Journ. Amer. Med. Assoc.*, August, 1908.
- ⁹ LaRoque, Paul: Some Anatomic and Physiologic Principles Concerning Pyloric Ulcer. *ANNALS OF SURGERY*, lviii, 1913.
- ¹⁰ Cole, Lewis Gregory: Physiology of the Pylorus, Pilleus Ventriculi and Duodenum. *Journ. Amer. Med. Assoc.*, 1913, p. 762.
- ¹¹ Alvarez, W. C.: The Motor Functions of the Intestine from a New Point of View. *Journ. Amer. Med. Assoc.*, lxxv, 1915, 338.
- ¹² Opie, Eugene: *Diseases of the Pancreas*. 2nd Ed., Philadelphia, 1910.
- ¹³ Wilkie, D. P. D.: Duodenal Diverticula and Duplication of the Duodenal Wall. *Edinburgh Med. Journal*, 1913.
- ¹⁴ Boas: quoted by Nothnagel, Hermann: *Diseases of the Intestines and Peritoneum*. Amer. Ed., 1905.
- ¹⁵ Sherren, James, quoted by Bland-Sutton, Sir John: On Cancer of the Duodenum and Small Intestine. *Brit. Med. Jour.*, October 17, 1914.
- ¹⁶ Moore and Bergin, quoted by Cannon, W. B.: *The Mechanical Factors of Digestion*. London, 1911.
- ¹⁷ Perry, Cooper and Shaw, Lauriston: On Diseases of the Duodenum. *Guy's Hospital Reports*, 1893.
- ¹⁸ Peck, C. H.: Gastric and Duodenal Ulcer. *ANNALS OF SURGERY*, 1915.
- ¹⁹ Bolton, Charles: Recent Observations on the Pathology of Ulcer of the Stomach, with Indications for Treatment. *Brit. Med. Jour.*, i, 1915, p. 707.
- ²⁰ Marquis: Perforation d'un ulcère peptique du jéjunum six ans après une gastro-entérostomie, etc. *Bull. et mém. soc. de chir.*, Paris, 1913, xxxix, 1517.
- ²¹ Callender, G. R.: Gastric Glands in Meckel's Diverticulum. *Amer. Jour. Med. Sci.*, cl, 1915, 69.
- ²² Alvarez, W. C.: Further Studies on Intestinal Rhythm. *Amer. Jour. Phys.*, xxxvii, 1915, 267.
- ²³ Steinharter, E. C.: Experimental Production of Gastric Ulcers by Intravenous Injection of Clumped Colon Bacilli. *Lancet Clinic*, 1914, cxl, p. 87.
- ²⁴ Rosenow, E. C.: Production of Ulcer of the Stomach by Injection of Streptococci. *Jour. Amer. Med. Assoc.*, November, 1913, p. 1947.
- ²⁵ Friedmann, J. C., and Hamburger, W. W.: Experimental Chronic Gastric Ulcer; *Jour. Amer. Med. Assoc.*, 1914, lxiii, 380.
- ²⁶ Keith, A.: A New Theory of the Causation of Enterostasis. *Lancet*, London, clxxxix, 1915, 371.
- ²⁷ Rolleston, H. D.: *Diseases of the Small Intestine*. Allbutt and Rolleston's System of Medicine. 2nd Ed., London, 1908.
- ²⁸ Rolleston, H. D.: *Diseases of the Liver, Gall-bladder and Bile-ducts*. Lond., 1912.
- ²⁹ Wilkie, D. P. D.: Observations on the Pathology and Etiology of Duodenal Ulcer. *Edin. Med. Jour.*, September, 1914.
- ³⁰ Houdard: L'ulcère simple du duodénum, non perforé. Thèse de doct., Paris, January, 1913.
- ³¹ Codman, E. A.: On the Importance of Distinguishing Simple Round Ulcers of the Duodenum from Those Ulcers which Involve the Pylorus or Are Above It. *Boston Med. Surg. Jour.*, clxi, 1909, Postscript 1.

ULCER OF THE DUODENOPYLORIC FORNIX

BY GEOFFREY JEFFERSON, M.S. (Lond.), F.R.C.S. (Eng.)
OF VICTORIA, B. C.

DUODENAL ulcers, as is well known, have a peculiar partiality for the part of the duodenum immediately adjoining the stomach. Thus Moynihan¹ states that at least 95 per cent. of them lie within one and one-half inches of the pylorus, whilst Paterson² gives their common site as half that distance. The incidence of duodenal ulcer in the portion of the intestine proximal to the bile papilla is very striking, indeed infrapapillary ulcer will probably be found to be a great rarity. The inference to be drawn from this fact as to the probable rôle of the gastric juice in the production of these ulcers is, of course, obvious.* The starting point of the majority of duodenal ulcers being so near the pyloric ring, it is not surprising that a certain number involve this structure and the fornix or sulcus which surrounds it. The complications which may then arise are discussed below.

The Duodenopyloric Fornix.—It will be remembered that the pylorus as viewed from the duodenum appears as a knob-like projection, which Cunningham⁴ likened to the cervix uteri. He wrote, "The extremity of the pyloric canal protrudes into the commencement of the duodenum so that, when viewed from the duodenal side, it presents the appearance of a smooth, rounded knob with a small puckered aperture, the pyloric opening in its centre, and surrounded by a shallow groove or fornix.

"The resemblance which it presents, as I pointed out many years ago, to the portio vaginalis of the cervix uteri is very striking. . . . The circular fibres are disposed in the form of a thick sphincteric muscular cylinder which surrounds the entire length of the [pyloric] canal. At the duodenopyloric constriction the margin of this cylinder becomes increased in thickness, forming thereby the massive muscular ring which encircles the pyloric opening and constitutes the pyloric sphincteric ring. The knob-like appearance presented by the extremity of the pyloric canal when viewed from the interior of the duodenum is produced by the presence, beneath the mucosa, of this muscular ring."

* Bolton* has shown that it is the hydrochloric acid of the gastric juice which causes ulceration after local injections of his "gastrotoxin," for they fail to appear if the gastric juice is kept neutralized. If this work is substantiated the term "peptic" ulcer becomes a misnomer.

The furrow which surrounds this knob is conveniently termed the duodenopyloric fornix. The depth of this sulcus varies very considerably in different individuals, being practically absent in many cases but very marked in others. The fornix is especially liable to be shallow in relaxed, hypotonic stomachs, whether seen at post-mortem or at operation, but is correspondingly deep in muscular, contracted specimens. The fornix, as we have seen, is due fundamentally to the muscle of the pyloric sphincter, but the eminence formed by the latter is accentuated by the mucous membrane which covers it. This last is frequently thicker on the duodenal aspect of the sphincter than it is immediately within the grasp of the same (Fig. 1 *A*). The writer has occasionally seen, in quite normal specimens, pockets of mucous membrane dipping beneath the general level of the floor of the fornix. This irregularity seems to be due in part to variations in the thickness of the submucosa and in part to the uneven line of the attachment to the pyloric ring of the longitudinal fibres of the duodenum. These small recesses must not be confused with the diverticula which sometimes develop in this region as the result of an ulcer (see Figs. 4 and 5 of Wilkie's paper ¹¹).

When it is remembered that gastric hypertonus is the rule in duodenal ulcer, as the radiographers have taught us, it will be evident that this sulcus is likely to be especially well marked in that condition. Truesdale ⁵ has recently furnished some anatomical evidence bearing on this point. From a study of the material removed at 15 pylorectomies he has shown that the musculature of the pyloric end of the stomach, including the sphincter, becomes considerably hypertrophied in ulcer cases, whilst it undergoes atrophy from partial disuse after gastro-enterostomy.

Clinical Importance of the Duodenopyloric Fornix.—The suprapapillary duodenum ^{**} is a comparatively simple, uncomplicated portion of the alimentary tract, somewhat egg-shaped ⁶ but smooth-walled, as the valvulæ conniventes do not commence till we reach the mound made by the underlying ampulla Vateri.† The absence of valvules makes a rapid examination of the interior of this part of the duodenum easy, so

^{**} Or alternatively "the supra-ampullary" duodenum.

† L. G. Cole ⁷ from his radiographical observations regards this proximal duodenum as part of the stomach. This view has also been advanced by Mayo and by Laroque. ⁸ Cole calls it the "cap" to the stomach or *pilleus ventriculi*. His really beautiful skiagrams (*loc. cit.*) well repay careful perusal. They show the silhouette of the duodeno-pyloric fornix very clearly. In most of Cole's figures it is rather shallow, but the relationship which an ulcer invading this situation bears to the pylorus is clearly demonstrated (see Fig. 10 *loc. cit.*).

that it is almost impossible to overlook an ulcer however small. When an ulcer lies in the posterior fornix, however, it is quite possible for it to be hidden to a certain extent by the projecting pylorus, and this the more readily owing to the backward turn towards the sagittal plane which the proximal duodenum takes. Incidentally, it may be remarked that this twist has been thought by some to explain the frequency of duodenal ulcer on the anterior paries (44 anterior to 19 posterior—Peck⁹), since the acid chyme will be projected primarily against this wall. Wilkie denies this and believes that the arterial supply of the bowel wall explains the site of ulceration. The hiding of an ulcer in the posterior fornix has been alluded to by W. J. Mayo.¹⁸ Difficulty in actual detection can only arise when the pylorus is markedly prominent and the ulcer small and recent.

There is a more important result of ulceration of the duodeno-pyloric fornix, however, and one which will be effective regardless of the depth of this circumpyloric furrow. The result referred to is obliteration, partial or complete, of the pylorus and its landmarks, rendering it difficult to decide at a glance whether the ulcer which is being dealt with is duodenal or gastric in origin. An ulcer of this kind is usually classed as "pyloric," which suggests that it has arisen from the stomach. The writer's belief is that a large proportion of such ulcers are truly duodenal and have originated in the duodeno-pyloric fornix. In support of this statement we may turn to the sites of election of chronic gastric and duodenal ulcer. The chronic ulcer of the stomach rarely involves the pyloric canal; it is usually found on the lesser curvature at the lower end of the gastric canal¹² at some distance from the pylorus.† This is in marked contrast with duodenal ulcer, which is rarely found further than one and one-half inches from that structure, and this last it may frequently involve. Laroque⁸ has expressed the belief that ulcer on the gastric side of the pylorus is perhaps a later development of duodenal ulcer. Graham's statistics, drawn from a large number of cases, show that the pylorus is involved more than twice as often by duodenal ulcer as by gastric.²²

Several instances of duodenal ulcer becoming malignant after extending into the stomach are now on record. Perhaps the most interesting are Sherren's two cases in which the duodenal portion of the ulcer

† Walker¹⁴ in a recent study has recorded 42 perforated gastric ulcers, all within 1½ inches of the pyloric. Most of these must, therefore, have been in the pyloric canal. This is a rather unique finding (compare, for instance, the similar studies of Percy Sargent, St. Thomas's Hospital Reports, 1904, and of John Morley, Practitioner, London, 1913).

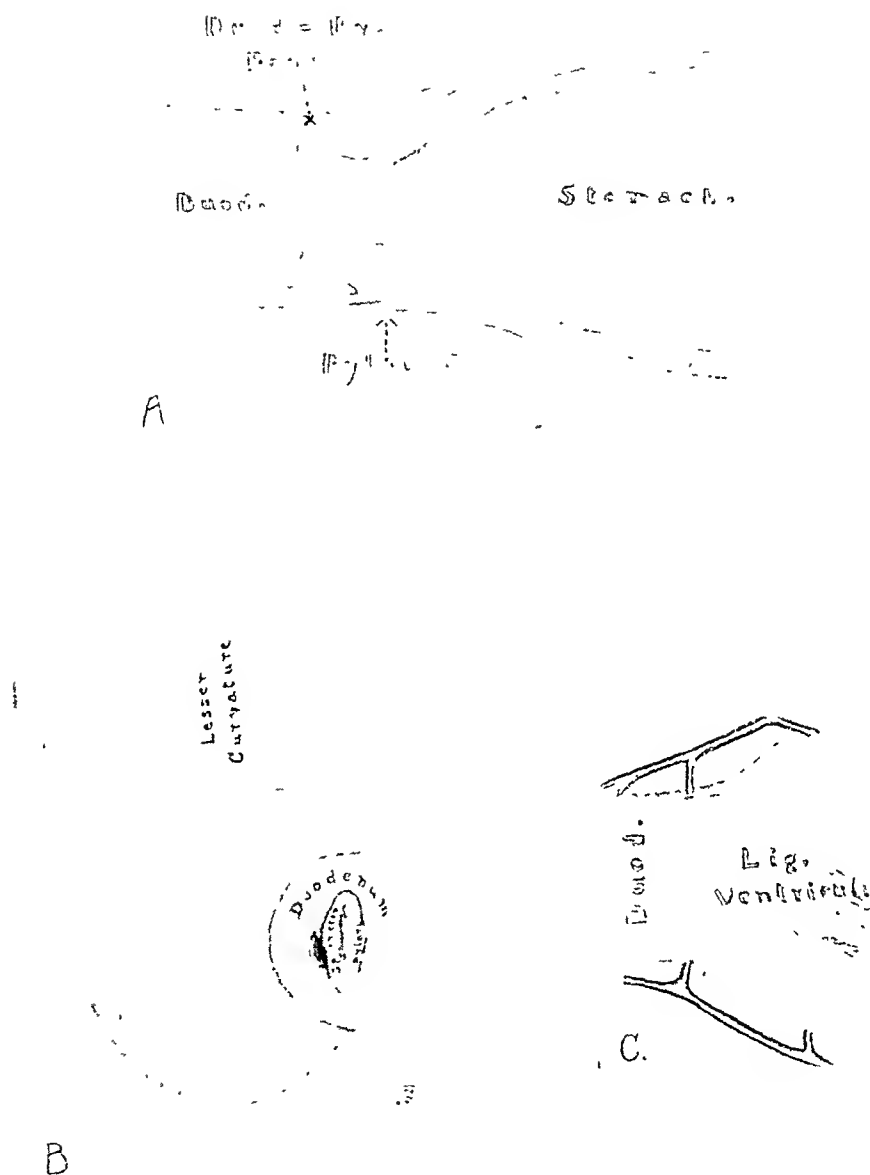


FIG. 1.—A. Horizontal section of the pars pylorica ventriculi and of the duodenum, to show the duodenopyloric fornix. B. Three-quarter end view of the proximal duodenum and the stomach, showing an ulcer in the duodenopyloric fornix. C. The pyloric veins, to illustrate how their short, stubby appearance is due to their disappearance beneath the ligamentum ventriculi or pylori. Drawn from specimens in the author's possession.

ULCER OF THE DUODENOPYLORIC FORNIX

had quite healed, whilst the gastric part had undergone carcinomatous metaplasia.¹⁵

The Pyloric Veins and the Duodenopyloric Fornix.—The value of an efficient orientating mark for the pylorus is well illustrated by the Mayo Clinic statistics which, with improved methods, have undergone a complete reversal. For whereas gastric ulcer was formerly supposed to be commoner than duodenal, they now see only one of the former to three of the latter. § Obliteration of the pyloric veins will very readily be brought about by an ulcer in the duodenopyloric fornix, particularly by one occupying an anterosuperior position, where it will underlie the superior vein—the more readily seen—and eventually destroy it. The value of these veins as landmarks is undoubted (the statements of Houdard¹⁸ and Hartmann and Lecène¹⁹ notwithstanding). The veins are four in number, two in front, two behind, above and below. Of these only the anterior are of practical value. A single vein, as described by Moynihan (*loc. cit.*, p. 265) and in the early paper of W. J. Mayo,²⁰ is not common. The later figures of the latter are much more accurate (Fig. 1¹³).

The veins are short and end rather suddenly by dipping beneath the external longitudinal muscle-coat, which here forms a specialized thickened band sometimes called the “ligamentum ventriculi” or “ligamentum pylori” (Fig. 1C). The veins are occasionally joined together by a superficial branch (Moynihan’s pyloric vein) which courses over the ligamentum ventriculi, but as their chief object is to carry away blood from the gastric wall the main portions of the veins rapidly disappear from sight. The writer’s own dissections, an account of which will appear later, have convinced him of the value of these veins as a surface marking, as it were, for the pylorus. What appears to be one vein on dissection proves to be many small branches, one of which is frequently seen passing through the fibrous ring which separates the circular muscle of the duodenum from the sphincter pylori. These vessels are so placed that a needle thrust through the wall of the duodenopyloric fornix would, as a rule, pierce them. It will be readily seen, therefore, how easily the pyloric veins may be involved by ulceration in this region. From the propinquity of an ulcer in this situation to the sphincteric fibres of the pylorus and the inevitable implication of the latter as the ulcer deepens and spreads, severe pain from pyloro-

§ The figures of most other clinics agree in the main with these: Peck,⁹ 73.3 per cent. duodenal, 26.7 per cent. gastric; Graham,¹⁶ 74.3 per cent. duodenal, 25.7 per cent. gastric; Sherren’s¹⁷ figures are more evenly balanced, with 51.5 per cent. duodenal to 48.5 per cent. gastric.

spasm might be expected before fibrosis has progressed far enough to hinder contraction, though the writer has no personal observations on this point.

It was not until after this paper was written that the author became acquainted with a very valuable paper by Codman, bearing on this subject.²¹ Codman, in a plea (which deserves much attention) for the correct differentiation of ulcers in the region of the pylorus, describes and illustrates how the pyloric ring may become invaded and destroyed by simple duodenal ulcerations.

CONCLUSIONS

1. Ulcer in the duodenopyloric fornix is very favorably situated for the obliteration, partial or complete, of the pylorus and its landmarks, the pyloric veins.

2. Difficulty may then arise in ascribing the ulcer to its correct source. Such an ulcer is usually described as "pyloric," which suggests that it is of gastric origin instead of duodenal.

3. Given a well-marked fornix, such as is likely to be present with a hypertonic stomach, an ulcer may be more or less hidden from view by the projecting pylorus, even after the duodenum has been opened.

BIBLIOGRAPHY

- ¹ Moynihan, Sir Berkeley: *Duodenal Ulcer*, 2nd edition, London, 1912.
- ² Paterson, H. J.: *The Surgery of the Stomach*, London, 1913.
- ³ Bolton, Charles: *Recent Observations on the Pathology of Ulcer of the Stomach, with Indications for Treatment*. *Brit. Med. Journ.*, 1, 1915, p. 707.
- ⁴ Cunningham, D. J.: *The Varying Form of the Stomach in Man and the Anthropoid Ape*. *Trans. Roy. Soc. Edinburgh*, vol. 45, 1906.
- ⁵ Truesdale, P. E.: *The Pylorus: Observations upon Its Musculature*. *Surgery, Gynecology and Obstetrics*, September, 1915.
- ⁶ Dwight (quoted by Todd, Wingate): *The Clinical Anatomy of the Gastro-intestinal Tract*. Manchester University Press, 1915.
- ⁷ Cole, Lewis Gregory: *The Diagnosis of Postpyloric (Duodenal) Ulcer*. *Lancet*, London, May, 1914.
- ⁸ Laroque, Paul: *Some Anatomic and Physiologic Principles Concerning Pyloric Ulcer*. *ANNALS OF SURGERY*, lviii, 1913, p. 321.
- ⁹ Peck, C. H.: *Gastric and Duodenal Ulcer*. *ANNALS OF SURGERY*, 1915.
- ¹⁰ Wilkie, D. P. D.: *The Blood Supply of the Duodenum, with Special Reference to the Supraduodenal Artery*. *Surgery, Gynecology and Obstetrics*, xiii, 1911, p. 399.
- ¹¹ Wilkie, D. P. D.: *Duodenal Diverticula and Duplication of the Duodenal Wall*. *Edinburgh Med. Journal*, 1913.
- ¹² Jefferson, Geoffrey: *The Human Stomach and the Canalis Gastricus (Lewis)*. *Journ. of Anat. and Phys.*, January, 1915; see also, *A Note on the Passage of Fluid Through the Body of the Human Stomach*. *Arch. of Röntgen Ray*, March, 1915.

ULCER OF THE DUODENOPYLORIC FORNIX

- ¹³ Mayo, W. J.: Chronic Duodenal Ulcer. *Journ. Amer. Med. Assoc.*, June, 1915.
- ¹⁴ Walker, I. J.: Acute Perforation of Ulcers of the Stomach and Duodenum. *Boston Med. and Surgical Journal*, clxxiii, 1915, p. 451.
- ¹⁵ Sherren, James: A Contribution to the Discussion on the Choice of Operation in Chronic Gastric and Duodenal Ulcer. *Surgery, Gynæcology and Obstetrics*, xix, 1914, p. 564.
- ¹⁶ Graham, C.: Notes on Gastric and Duodenal Ulcer. *Trans. Marshfield Clinical Meeting, Marshfield, Wis.*, 1915; *Surgery, Gynæcology and Obstetrics, International Abstract of Surgery*, September, 1915, p. 262.
- ¹⁷ Sherren, James: Diagnose und chirurgische Behandlung des Magen und Duodenalgerchwürs. *Berliner klinisch Wochensch.*, 1, 1913.
- ¹⁸ Houdard: L'ulcère simple du duodenum, non perforé. *Thèse de doct.*, Paris, January, 1913.
- ¹⁹ Hartmann, H., and Lecène, P.: Ulcer of the Stomach and of the Duodenum. *ANNALS OF SURGERY*, August, 1914.
- ²⁰ Mayo, W. J.: A Better Understanding of the Gastric and Duodenal Ulcer. *ANNALS OF SURGERY*, June, 1907.
- ²¹ Codman, E. A.: On the Importance of Distinguishing Ulcer of the Duodenum from those Ulcers which Involve the Pylorus or Are Above It. *Boston Medical and Surgical Journal*, clxi, 1909, p. 313.
- ²² Graham, C.: Observations on Peptic Ulcers. *Boston Medical and Surgical Journ.*, 1914, clxx.

CYSTIC DILATATION OF THE VERMIFORM APPENDIX

REPORT OF A CASE OF HYDROPIC CYST, WITH A STUDY OF 142 CASES

BY GEORGE E. DODGE, M.D.

OF TUCSON, ARIZONA

FORMERLY INSTRUCTOR IN SURGERY, CORNELL UNIVERSITY MEDICAL COLLEGE, NEW YORK CITY

THIS infrequent condition has been designated variously as retention cyst, hydrops, mucocoele, colloid cyst, pseudomucous cyst of the appendix, and cystic disease of the appendix. Virchow first described the condition in 1863. Rokintansky in 1867 described four cysts which he considered examples of colloid carcinoma. A number of later writers have expressed doubt as to the neoplastic character of these tumors. Feré in 1877 described a specimen found at autopsy which he designated as a mucocoele. Wölfler in 1879 was the first to report the occurrence of an appendiceal cyst in a hernial sac. In 1880 Wier exhibited a case in which an incision had been made over the tumor and drainage instituted. He regarded the condition as an appendiceal cyst, and recalled a case he had seen in Bellevue Hospital two years previously, that had been similarly drained and had healed. In 1887 Vimont reported a cyst which he referred to as a mucocoele. During the following two decades many important contributions were made to the subject. Among these may be mentioned the papers of Guttman 1891, Ribbert 1893, Van Hook 1896, Stengel 1906, Corning 1906, McConnell 1907, and J. A. Kelly in 1909. Van Hook collected 33 examples of cysts from the literature, including his own case, which occurred in a hernial sac. Kelly tabulated 68 cases. Crouse in 1910, in a general study of appendiceal tumors, tabulated a total of 89 cysts, including the material of Kelly and Van Hook.

Frequency.—Castle has cited recently the autopsy records of Ribbert, Bryant, Steiner, Boody, Kelly and Hurdon, Stengel, Heineck and Castle, a total of 13,158 autopsies, and found a total of 28 cases or about 0.2 per cent.

Corning, out of 935 appendices sent to his laboratory from the operating room, found only 5 cysts, 0.68 per cent.

After a rather extended search of the literature and a careful examination of the material in Van Hook's, J. A. Kelly's and Crouse's tables, and after rejecting a few cases evidently not appendiceal cysts and adding a number of cases not previously listed, the writer is able to collect a total of only 142 cases. Of these 55 are reported from

CYSTIC DILATATION OF THE VERMIFORM APPENDIX

autopsies, 66 from operations, and in 21 cases the information was not recorded or was not accessible.

Incidence.—In these cases 37 were in males, 34 in females, and in 71 the sex was not recorded.

The age incidence was as follows:

| | Operation | Autopsy | Combined |
|-------------------|-----------|---------|----------|
| 1-10 years | 0 | 0 | 0 |
| 11-20 years | 6 | 2 | 8 |
| 21-30 years | 6 | 4 | 10 |
| 31-40 years | 7 | 0 | 7 |
| 41-50 years | 5 | 2 | 7 |
| 51-60 years | 3 | 4 | 7 |
| 61-70 years | 3 | 5 | 8 |
| 71-80 years | 1 | 3 | 4 |
| 81-90 years | 0 | 1 | 1 |

Age not recorded in 88 cases.

In the operative cases 34 were found at operations for appendicitis or for acute or chronic disturbances connected with the right iliac region with or without a diagnosis; 15 during the course of operations on other organs. In 17 cases records were inconclusive.

Etiology.—As recognized etiological factors may be mentioned:

(a) The so-called normal involution or obliterative process (now believed by most pathologists to be inflammatory) occurring in such manner that occlusion takes place at some point between a secreting area and the base of the appendix; (b) general proliferative and ulcerative inflammatory processes; also, possibly, (c) specific infections, as typhoid, tuberculosis and syphilis; and, possibly, (d) malignant changes. As occasional and contributory causes may be mentioned angulation, torsion and compression of the lumen by external adhesions. Habitual distention of the cæcum causing closure of Gerlach's valve has also been suggested as a factor.

Out of 142 cases, evidences of chronic inflammation were definitely recorded in 45 cases.

Typhoid ulceration was given as a possible factor in 1 case (Castle).

Tubercular lesions were present in the cæcum and appendix in 1 case (Wenzel-Gruber).

In the case reported by Lilienthal syphilitic infection had been present during the month preceding the operation, in which period alone the patient suffered from appendiceal symptoms; but whether the luetic process had been present long enough to have induced cyst formation is somewhat doubtful.

Garrow and Keenan report a case in which the occluding nodule, at

first thought to be inflammatory, disclosed itself on microscopic section to be a cubical-celled carcinoma invading all of the coats of the appendix.

Landenberger reports a case where two very severe concussive injuries initiated symptoms that led to operation eleven months later. There were no adhesions or evidences of inflammatory processes outside of the appendix, but the lumen was obliterated. There was no histopathic report. This traumatic history is paralleled somewhat by that given in Neumann's case.

It is evident from a study of appendiceal cysts that they are due to the retention of normal or altered products of secretion, to which may be added later the products of disintegration and degeneration. The immediately correlated factors are secretion, resorption and usually a more or less complete occlusion of the lumen. Secretion on the one hand must be in excess of resorption and discharge on the other.

Out of 37 cases studied in which the condition of the lumen was definitely described, in 26 the lumen was completely obliterated and in 5 was nearly or partially obliterated.

That complete or partial obliteration of the lumen is not essential in all cases is shown by the records of 5 otherwise typical cases in which the lumen is recorded as distinctly patent. In all the cases, however, in which the lumen is recorded as free, the contents are described as very thick and tenacious.

It is quite probable that in these cases the action of the muscularis is inefficient (Latham) or its structure impaired. In only one of these cases with open lumen do we have a record of the condition of the muscularis, that of Phemister, and in this case it is completely absent.

The absence of infective organisms from the involved portion of the lumen may be considered as a necessary condition for cyst development. In the six cases in which infection was present, empyemata, the specimens were all small in size.

Phemister has made some interesting attempts to produce cyst formation experimentally in dogs, by artificial obliteration of the appendix lumen. The results, however, were unsatisfactory. In all the cases but one, gangrenous appendicitis supervened. In the single case where this complication was avoided, the appendix lumen became restored.

Pathology.—Size: In 51 cases the size of the cyst was small, up to 3 cm. in length; in 33 cases it was medium, $3\frac{1}{2}$ to 9 cm.; and in 11 cases the size ranged from 9 cm. up. In 47 cases the size was not accurately recorded.

The largest specimens of which we have an account are probably

CYSTIC DILATATION OF THE VERMIFORM APPENDIX

that of Neumann, disclosed at operation on a man aged sixty-nine, and described as being as large as a man's head; that described by Guttman, found at autopsy on a woman aged seventy, pear-shaped, 14 cm. long and 21 cm. in its greatest circumference; and that of J. A. Kelly, found at autopsy, the size and shape of a very large banana, curved at its base into a hook shape, and 30 cm. long on its greatest curvature and with a greater circumference of 15 cm. Wood's specimen, removed at operation from a woman aged fifty-two, was sausage-shaped, 20 cm. in its greatest length and had a diameter of 7 cm. Phemister's specimen removed at operation from a middle-aged woman was 17 cm. in length and its greatest circumference was 21 cm. Noble's specimen, also removed at operation, had a length of $7\frac{3}{4}$ inches and a circumference at its distal end of $5\frac{3}{4}$ inches.

It will be noted that the largest two specimens were found in subjects in advanced life, while the two next larger ones occurred in subjects around middle age.

Shape: Perhaps the largest number of medium-sized and large cysts have been described as sausage-shaped or banana-shaped and as pear-shaped. They have been described also as comma-shaped, sigmoid and globular. Many of the smaller cysts have been described as fusiform, sacculated, and egg-shaped. They may be found occupying any portion of the lumen of the appendix.

The entire appendix was involved in 23 cases; a portion of the appendix in 38 cases; the site was not definitely recorded in 81 cases.

Contents: In 59 cases the contents were described as either mucoid, colloid, gelatinous or pseudomyxomatous; in 13 cases they were described as watery, liquid, or serous (hydrops); in 6 cases as purulent; in 1 case the contents were described as putty-like; 2 cases showed dark areas of extravasated blood; and 2 cases, those of Latham and Cagnetto, showed the gelatinous contents arranged in a mass of small, shot-like bodies; gaseous frothy contents were found in Gildersleeve's case.

A yellowish or grayish color is usually ascribed to the contents of these cysts.

The character of the cyst contents seems to vary with the condition of the mucous membrane and the degree of change taking place in the cyst walls. It is probable that the secretion is at first always mucoid; and in connection with this condition there may be thickening of the mucous and muscular coats. Later on, as the effects of continued pressure make themselves evident on the cyst walls, there are added further products of hyaline or myxomatous degeneration of fibrous elements,

possibly lending a gelatinous character to the contents. These changes may take place in varying degrees in different parts of the cyst wall so that the continuous addition of mucous elements may take place parallel with gelatinous changes, and this may in a measure account for the arrangement of the contents as well as the great quantity of material at times accumulated.

Adhesions were not noted as often as might be expected. They are recorded as being present in 13 cases; as absent in 7 cases; and are not recorded in 122 cases.

Diverticula of various sizes are described either as protrusions from the walls of an already well-defined cyst or as springing from any portion of the wall of the dilated appendix. They are especially noted 12 times in this series. But the smaller forms of diverticula are probably much more frequent. They are seen as evaginations on the surface of many of the larger cysts.

Ribbert was the first to describe this condition. In his opinion it usually is due to protrusion of the mucosa through the thinned or partially destroyed muscularis. In some cases he thinks they may be due to cystic degeneration of the glands of the mucosa. Oberndorfer thinks that these processes have their origin in ulcerated areas in the mucosa and Crowell demonstrates this condition in his specimen.

Foreign writers have used the term "hydrops" rather loosely. True hydrops is really a rare condition occurring in only about 9 per cent. of all cysts tabulated. According to Leube it is the result of advanced pressure changes on the thinning walls, bringing the blood-vessels of the submucosa into a more superficial relation to the surface and allowing a transudate of the more fluid portions of the blood. There is further a lessened production of mucus due to atrophy of the mucosa. Complete occlusion of the lumen would seem a necessary accompaniment to the condition. In the 6 examples of this condition in which the state of the lumen is recorded it is described as completely closed.

Histopathology.—Where the walls of the appendix outside the area of cyst formation have been studied they have usually shown the evidences of acute and chronic inflammatory change, thickening, ulceration, round-celled infiltration and connective-tissue proliferation. The lumen may be in a state of complete or partial obliteration or may be patent.

The walls of the cysts show in general the changes due to inflammation and pressure. The mucosa may be more or less uniformly thinned, it may disclose areas of ulceration and infiltration, it may be

CYSTIC DILATATION OF THE VERMIFORM APPENDIX

absent in places, or it may be completely destroyed. On its surface at times may be seen secreting and disintegrating cells, and platelets of lime salts may be adherent. The muscularis mucosæ may be hypertrophied or later replaced by fibrous elements. The changes in the submucosa correspond in general to those in the mucosa. It may show flattened and atrophic lymph follicles. The muscular coat may show great thickening in the early stages of cyst formation, as shown in many of the smaller specimens. Later it becomes greatly thinned or else completely replaced by fibrous tissue. The serous coat at first shows hyperplasia of blood-vessels; later they may become greatly attenuated. Fibrous thickening may take place.

Ogilvie has reported a case recently in which nearly the entire wall of the cyst was replaced by lime salts.

The cyst contents may be amorphous or when of thick consistence often will show a lamellated structure; and a striated, fibrillar or reticulated arrangement may be distinguished at times, either alone or in combination with lamellation. These fibrils apparently result from degenerative processes in the connective tissue. Degenerated cellular elements at times may be observed and occasionally pigmented areas, the result of disintegration of red blood-cells. Scattered platelets of lime salts not infrequently are found throughout the mass and occasionally fatty crystals and cholesterin.

Chemical Examination.—In only 6 cases are the results of chemical examination of cyst contents definitely recorded. In 3 the reaction was stated as mucin; in 2 as pseudomucin; and in 1 as colloid.

Symptoms.—A study of the records of operative cases shows appendiceal symptoms to have been present more frequently than has been supposed by many writers.

In 66 operative cases a history of pain, discomfort or other symptoms referable to the right iliac fossa was recorded in 34 cases, 51 per cent.; symptoms were either absent or obscured by other conditions in 14 cases; they were not recorded in 18 cases.

Autopsy records in the past have been too deficient in respect to clinical data to form a fair basis for the estimation of the frequency of symptoms.

In 55 autopsy cases symptoms were noted as absent in 3 cases; present in 1 case; and not recorded in 51 cases.

Diagnosis.—In no case was a diagnosis made or suggested previous to operation with the single exception of Ogilvie's case, an easily palpable calcareous cyst, in which the diagnosis lay between a calcareous cyst of the appendix and a ureteral calculus. In 13 cases the diagnosis

of chronic appendicitis was definitely made. In one case the diagnosis of acute appendicitis was made. In 6 cases the operation was done for acute or chronic abdominal symptoms, more or less referable to the right iliac fossa, but without diagnosis.

In Phemister's and Wilson's cases the diagnosis had been that of ovarian cyst.

In Hartman and Kindley's case the diagnosis of floating kidney had been twice made and a fixation operation performed previously. At the second operation the incision was extended and the true nature of the condition discovered.

Weinhold removed a pedunculated cyst from a woman aged seventy-four, on whom he had made the diagnosis of a pedunculated uterine fibroid.

The diagnosis of probable new growth of the intestines was made in Crawford's case, the patient being a man of sixty-three with tumor and beginning obstructive symptoms.

In Neumann's case, a subject with a traumatic history was operated upon with a diagnosis of probable infected hæmatoma.

Prognosis.—As would be expected the course following the removal of these simple cysts has been uniformly favorable.

Complications.—*Infections:* The clinical occurrence of acute pyogenic processes has been noted. In Lilienthal's case, healing of the abdominal wound would not take place until syphilitic treatment had been instituted.

Occurrence in hernial sacs: Three cases of this condition have been reported, those of Wölfler, McArthur and Van Hook.

Rupture of cyst: This occurred in Van Hook's case from previous attempts at reduction of the hernial sac. In one of Wilson's cases it resulted from a very gentle bimanual examination.

Lubarsch, Roberg, and Fränkel record the spontaneous rupture or perforation of the cyst with extravasation of portions of the contents into the peritoneal cavity and the formation of pseudomyxomatous masses. In Moore's case in which the peritoneum was similarly involved, the appendix was disintegrated, and in Trotter's case it could not be found.

Pseudomyxoma peritonei: The last group of cases brings into consideration this interesting condition. It is a well-recognized clinical phenomenon that under certain conditions the contents of appendiceal cysts, like those of certain ovarian cysts, are capable of causing proliferation when implanted upon the surface of the peritoneum. The condition has been studied by Werthe, Lubarsch, Wilson, Trotter,

CYSTIC DILATATION OF THE VERMIFORM APPENDIX

McConnell and others. Werthe first showed the condition to be one of inflammatory reaction of the peritoneal cells. Wilson claims that metastases such as occur in ovarian pseudomyxomata have not been observed in appendiceal cases as yet. And Trotter, in this connection, says that the cubical and columnar cells described in the gelatinous contents by different observers, and attributed by some to proliferation of the epithelial cells of the appendix, are more probably due to transformation of the peritoneal endothelium. Lubarsch and McConnell, from a study of their own specimens and those of Rokitsansky, Draper, Vimont, Baillet and Stengel, are inclined to the view that there is an actual transference and proliferation of the cells of the appendiceal mucosa, and to regard such cases as true adenocystomata.

The writer has been able to collect 14 reported examples of pseudomyxoma peritonei, those of Fränkel, Merkel, Lubarsch, Oberndorfer, Hüter, McConnell, Roberg, Neumann, Moore, Cramer, Eden, Wilson, Rathe and Hammesfahr. Nager's case was described by him as a lymphangio-endothelioma, but Neumann considered it to be an example of pseudomyxoma peritonei.

Carcinoma.—Stengel has made a careful study of the histopathic character of the cases reported by Rokitsansky. They would seem to have had no additional heterotopic features to the cases which Lubarsch and McConnell have classed as adenocystomata. In common with these cases they appear to have lacked the general clinical aspects of malignant disease and showed no tendency to metastases.

In 1884, DRAPER reported a case found at autopsy in a sixty-five-year-old man in whom death was apparently due to the condition in the cæcum and appendix. Draper described the condition as colloid carcinoma. The base of the appendix was dilated into a thick-walled cyst communicating freely with the cæcum. He described the irregular, infected, thickened wall of the cyst as having the characteristic appearance of colloid disease. There was no histopathic report.

In 1913 ELTING reported a case observed at autopsy in a male aged eighty-one. The cyst was 5½ cm. long and 3 cm. in diameter, and filled with a yellowish-green, transparent gelatinous material, presenting a striated and lamellated appearance and which protruded from a perforation in the wall. The mucosa had apparently disappeared. The submucosa and muscularis were found to be invaded by a new growth, composed of glandular structures closely arranged with very little stroma. Diagnosis: Primary adenocarcinoma of the appendix, belonging to the type which is generally known as colloid carcinoma.

ROBERG's case has been previously cited. He was at first inclined to regard it as one of colloid carcinoma but on further study placed it in the class of pseudomyxoma peritonei.

In 1903 NORRIS reported a case of primary carcinoma of the appendix removed at operation. The patient was well 8 months after operation. The cystic character of this specimen was not conspicuous.

More recently McWilliams has tabulated 3 cases of carcinoma occurring in cysts those of Jong, Landau and Pauchet. MacCarty and McGrath have tabulated 2 cases, and Garrow and Keenan 1 case. In Jong's case the condition was recorded as a spheroidal-celled carcinoma; the meso-appendix was not involved and the patient was reported well after two years. Landau's case was described as a spheroidal-celled carcinoma and the meso-appendix was not involved. Pauchet's case was designated columnar-celled; the meso-appendix was not involved; the pedicle was twisted.

Chronic inflammatory lesions were recorded in two of McWilliams's cases. and in MacCarty's and McGrath's cases the condition was secondary to inflammatory processes. Garrow and Keenan describe the condition in their case as primary.

Report of Case of Hydropic Cyst.—Patient is a pale, well-developed, but rather poorly nourished man, aged twenty-nine. Thinks he had no more abdominal disturbance in childhood than is usual with children, but always suffered from constipation, and when a boy had two attacks of pain in the abdomen that required a physician's services. One year ago had a severe attack of pain in the right inguinal region that continued with more or less discomfort for one month. One month ago had another severe attack, confining him to bed for one week and having the general character of an acute appendiceal exacerbation. Has had 6 or 7 attacks in all in the past year, and since the last attack his bowels have been very hard to move, and discomfort has been nearly constant. *Diagnosis:* Chronic appendicitis.

Operation (February 11, 1915).—One month after last attack. Through a rectus incision the appendix presented itself as a grayish-white, tense and very thin tumor the size and shape of a breakfast sausage. It was attached to the base of the cæcum by a narrow cord about 1 cm. long. The base was free but the outer half was rather firmly adherent to the cæcum, the parietal peritoneum and a coil of small intestine. These adhesions required to be freed with some care to avoid rupturing the cyst. The pedicle was ligated and the tumor removed. Recovery was uneventful.

Pathological Report.—Gross examination shows a grayish-white, tense, thin-walled, somewhat sausage-shaped cyst. A few fine blood-vessels are seen branching on its surface. It measures 10½ cm. in length. Its width is 3 cm. at the base and it tapers slightly toward the distal end. The outer cyst wall shows a number of small nodular projections on its surface. The inner wall is quite smooth and shows diverticula or evaginations corresponding to the external projections. The cyst wall is of paper thinness and transparent throughout. The fluid removed from the cyst measures 30 c.c. It is thin, watery and slightly opalescent and contains a few flakes of fibrin.



FIG. 1.—Hydropic cyst of the appendix (reduced one-half). Removed at operation. Length $10\frac{1}{2}$ cm. Greatest diameter 3 cm. Three small diverticula are seen near the distal mesenteric attachment.

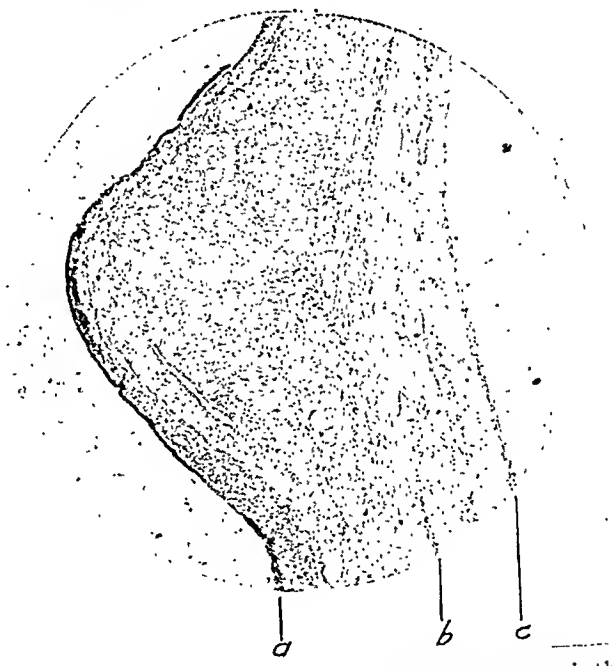


FIG. 2.—Section of the cyst wall, showing, *a*, the remains of the mucosa; *b*, the greatly attenuated muscularis; *c*, the serosa.

CYSTIC DILATATION OF THE VERMIFORM APPENDIX

Microscopic examination of sections of the pedicle of this tumor, the original base of the appendix, shows it to be merely a fibrous band with no lumen.

Sections of the cyst wall reveal only a thin layer of epithelial cells, representing the remains of the mucosa. The muscularis is greatly attenuated and fibrous. There is considerable round-celled infiltration in places. The serosa is thickened and fibrous.

Chemical examination of the cyst fluid was inconclusive, owing possibly to the presence of preservative.

Condensed Table of Cases and Literature.—In the original tabulation the following factors were considered: Source of case; history; age; sex; diagnosis; complications; general conditions present, size, shape and contents of cyst, state of lumen and portion of appendix involved; presence of adhesions; presence of diverticula; microscopic examination of appendix wall, cyst wall and contents; chemical examination of contents. In a few cases the original articles were not accessible and the descriptions of other authors were utilized.

CONCLUSIONS

1. That cystic dilatation of the appendix is a relatively infrequent condition.

2. That true hydrops of the appendix is rare. Probably less than 9 per cent. of all appendiceal cysts.

3. That appendix cysts are essentially retention cysts and of inflammatory origin.

4. That the condition by no means runs a symptomless course; symptoms being present in at least 51 per cent. of operative cases, and 24 per cent. of all cases.

5. That the contents of certain appendiceal cysts, when implanted upon the peritoneal surface, are capable of producing a condition of pseudomyxoma peritonei.

6. That certain appendiceal cysts present structural and clinical characters that seem to ally them with adenocystomata.

7. That carcinomatous changes occasionally take place in appendiceal cysts.

I wish to express my thanks to Dr. Philip Hillkowitz of Denver, Colo., for the pathological examination of the specimen and the preparation of sections and to Dr. A. J. Markley of Denver for the microphotograph.

| No. | Author | Source | Sex | Age | Reference | Condition |
|-----|---------------------------|--------|-----|-----|---|--|
| 1 | Baillet..... | Op. | F. | .. | Bull. de la Soc. Anat. de Paris, 1891, v, 66, p. 67 | Mucous cyst. |
| 2 | Baldwin..... | Op. | F. | 40 | Brooklyn Med. Jour., June, 1904..... | Gelatinous cyst. |
| 3 | Barber..... | Op. | .. | .. | Referred to by Baldwin..... | Gelatinous cyst. |
| 4 | Berry..... | Aut. | M. | 77 | Journ. of Path., April, 1895..... | Mucous cyst. |
| 5 | Bierhof..... | Aut. | .. | .. | Deut. Arch. f. klin. Med., 1880, xxvii, 3, s. 248.. | Small mucous cyst. |
| 6 | Bierhof..... | Aut. | .. | .. | Deut. Arch. f. klin. Med., 1880, xxvii, 3, s. 248.. | Small cyst, serous contents. |
| 7 | Bierhof..... | Aut. | .. | .. | Deut. Arch. f. klin. Med., 1880, xxvii, 3, s. 248.. | Mucous cyst. |
| 8 | Bierring..... | Op. | .. | .. | Discussion of Stengel's case..... | Mucous cyst. |
| 9 | Biggs..... | Aut. | .. | .. | Med. Rec., vol. 43, p. 536..... | Mucous cyst. |
| 10 | Biggs..... | Aut. | .. | .. | Med. Rec., vol. 43, p. 536..... | Strictured appendix. |
| 11 | Boody..... | Aut. | .. | .. | Am. Med., August 16, 1902, p. 202..... | Liquid contents. |
| 12 | Cagnetto..... | Aut. | F. | 70 | Virchow's Archiv, Bd. 198, H. 2, s. 193..... | Gelatinous cyst. |
| 13 | Castle..... | Op. | M. | 33 | ANNALS OF SURGERY, May, 1915, p. 582..... | Gelatinous cyst. |
| 14 | Chevrier..... | Op. | M. | 30 | La Revue Méd. du Canada, 1903-1904, p. 15..... | Small serous cyst. |
| 15 | Combemale..... | Aut. | .. | .. | Bull. Méd. du Nord, 1891, p. 223..... | Designated hydrops. |
| 16 | Combemale..... | Aut. | .. | .. | Bull. Méd. du Nord, 1891, p. 223..... | Designated hydrops. |
| 17 | Coats..... | Aut. | .. | .. | Glasgow Med. Jour., 1875, p. 126..... | Tip of appendix. |
| | Coats (from Stengel)..... | Aut. | .. | .. | Cited by Kelynaek. Manual of Path., 2d Ed., p. 173..... | Gelatinous cyst. |
| 18 | Corning..... | Op. | M. | 16 | Albany Med. Annals, December, 1905, xxvi..... | Gelatinous cyst. |
| 19 | Corning..... | Op. | F. | 50 | Albany Med. Annals, December, 1905, xxvi..... | Gelatinous cyst. |
| 20 | Corning..... | Op. | M. | 36 | Albany Med. Annals, December, 1905, xxvi..... | Described as colloid. |
| 21 | Corning..... | Op. | F. | 60 | Albany Med. Annals, December, 1905, xxvi..... | Gelatinous cyst. |
| 22 | Cramer..... | .. | F. | .. | Trans. Gyn. Soc., Chicago, 1911, p. 373..... | Gelatinous cyst. Pseudomyxoma peritonei. |
| 23 | Crawford..... | Op. | M. | 63 | Iowa Med. Jour., September, 1909, p. 129..... | Character of contents not stated. |
| 24 | Crouse..... | .. | M. | .. | Surg., Gyn. and Obs., November, 1910, p. 457... | Cases noted separately. |
| 25 | Crowell..... | Aut. | M. | 40 | Philippine Jour. of Science, February, 1912..... | Gelatinous cyst. |
| 26 | Deaver..... | Aut. | F. | .. | Treatise on Appendicitis, Philadelphia, 1900..... | Mucous cyst; size of orange. |
| 27 | Dodge..... | Op. | M. | 29 | Described in this paper..... | Hydropic cyst. |
| 28 | Draper..... | Aut. | M. | 65 | Brit. Med. and Surg. Jour., 1884, 110, vi, p. 131. | Colloid carcinoma. |
| | Eden..... | Op. | F. | .. | Lancet, 1912, p. 1498..... | Gelatinous cyst. Pseudomyxoma peritonei. |

CYSTIC DILATATION OF THE VERMIFORM APPENDIX

| | | | | | | |
|----|-----------------------------|------|----|----|--|--|
| 29 | Elting..... | Aut. | M. | 81 | ANNALS OF SURGERY, 1903, xxxvii, p. 549. | Colloid carcinoma. |
| 30 | Fenwick..... | Aut. | M. | .. | Cited by Kelyack..... | Milky contents; a hydrops. |
| 31 | Peré..... | Aut. | M. | 55 | Le Prog. Méd., Paris, 1877, vol. 5, p. 73. | "Mucocele." |
| 32 | Finklestein..... | .. | .. | .. | Described under Guttman. | |
| 33 | Förster..... | .. | .. | .. | Cited by Wölfler as having had a case. Reference not given. | |
| 34 | Fraenkel..... | Aut. | M. | 79 | Münch. Med. Woch., 1901, xxiv, s. 965. | Pseudomucinous cyst. Pseudo-myoxma peritonei. |
| 35 | Garrow and Keenan.... | Op. | F. | 21 | ANNALS OF SURGERY, October, 1908. | Cubical-celled carcinoma. |
| 36 | Gildersleeve..... | Op. | M. | 43 | Brooklyn Med. Journ., August, 1904, p. 318. | Gaseous frothy contents. |
| 37 | Glassmacher..... | Aut. | F. | 70 | Cited by Van Hook..... | Empyema. |
| 38 | Guttman..... | Op. | F. | .. | Deut. Med. Woch., 1891, s. 260. | Described as a hydrops. |
| 39 | Hartman and Kindley.. | .. | .. | .. | Jour. A. M. A., 1904, p. 1795. | Pseudomucinous cyst. |
| 40 | Hawkins..... | .. | .. | .. | Diseases of Verm. Appendix, London, 1895. | Empyema. |
| 41 | Hawkins (from Stengel). | Op. | F. | .. | Diseases of Verm. Appendix, London, 1895. | Empyema. |
| 42 | Hämmesfahr..... | Op. | F. | .. | Deut. Med. Woch., July 31, 1913. | Pseudomucinous cyst. |
| 43 | Hämmesfahr..... | Op. | .. | .. | Deut. Med. Woch., July 31, 1913. | Pseudomucinous cyst. Pseudo-myoxma peritonei. |
| 44 | Heckteon..... | .. | .. | .. | Described under Jaggard. | |
| 45 | Herb..... | Aut. | .. | .. | Tr. Chic. Path. Soc., 1907. | Large diverticulum. |
| 46 | Hirst..... | Op. | .. | .. | Referred to by Stengel..... | Mucous cyst. Possible pseudo-myoxma peritonei. |
| 47 | Hueter..... | .. | .. | .. | Ziegler's Beirtrage, 1907, Bd. 41, s. 517. | Gelatinous cyst. Pseudomyoxma peritonei. |
| 48 | Jaggard..... | Op. | F. | 47 | Am. Jour. Obs., 1893, xxviii, p. 226. | Empyema. |
| 49 | Jong..... | Op. | F. | .. | Mitt. Aus. d. Grenz d. Med. u. Chir., 1907, xviii, No. 3 | Spheroidal-celled cancer. |
| 50 | Kelly, J. A..... | Aut. | M. | 43 | ANNALS OF SURGERY, April, 1909, p. 524. | Large gelatinous cyst. |
| 51 | Kelly and Hurdon (16 cases) | Aut. | .. | .. | The Verm. Appendix and Its Diseases. Philadelphia and London, 1905, p. 250 | All small mucinous or gelatinous cysts. |
| 52 | Kelyack..... | Aut. | F. | .. | The Path. of the Verm. Appendix, London, 1893 | Gelatinous cyst. |
| 53 | Kennedy..... | Op. | F. | .. | N. Y. Med. Journ., March 22, 1913. | Mucinous cyst. |
| 54 | Klemm..... | Op. | F. | 16 | Münch. Med. Woch., 1905, No. 4. | Small empyema. |
| 55 | Klemm..... | Op. | M. | 37 | Münch. Med. Woch., 1905, No. 4. | Small empyema. |
| 56 | Klemm..... | Op. | M. | 26 | Münch. Med. Woch., 1905, No. 4. | Small empyema. |
| 57 | Lafforgue..... | Op. | F. | 50 | Gaz des Hôpit., Paris, 1904, lxxvii, p. 33. | Small granular mucous masses. |
| 58 | Latham..... | Aut. | .. | .. | Notnagel's Encl. of Med., New Am. Ed. | Cyst filled with shot-like bodies. |

| No. | Author | Source | Sex | Age | Reference | Condition |
|-----|-------------------------|--------|-----|-----|--|---|
| 73 | Landau..... | Op. | F. | 33 | Ber. Klin. Woch., 1906, December 10..... | Spheroidal-celled cancer. |
| 74 | Landenberger..... | Op. | M. | 32 | N. Y. Med. Rec., 1904, lvi, p. 856..... | Hydrops. |
| 75 | Leube..... | Op. | M. | 23 | Ziemssen's Encyclopedia, vol. vii. | "Colloid" cyst. |
| 76 | Lilienthal..... | Op. | M. | 69 | N. Y. Med. Jour., 1903, lxvii, p. 233..... | Pseudomyxoma peritonei. |
| 77 | McArthur..... | Op. | M. | 50 | Ergebn. d. Allgem. Path. u. Path. Anat., 1903, vol. xviii, s. 847. | Small cyst in hernial sac. |
| 78 | McConnell..... | Aut. | M. | 50 | Am. Jour. Obs., August, 1893, vol. 28, p. 275.... | Pseudomyxoma peritonei. |
| 79 | MacCarty and McGrath | Op. | F. | 25 | Internat. Clinics, 1907, vol. 4, Series 17..... | Carcinoma in chronic cystic ap- pendix. |
| 80 | MacCarty and McGrath | Op. | F. | 36 | ANNALS OF SURGERY, lix, 1914..... | Colloid carcinoma. |
| 81 | MacLean..... | Op. | M. | 20 | Munch. Med. Woch., August 18, 1908, s. 1746.. | Empyema. |
| 82 | McWilliams..... | Op. | M. | .. | Am. Journ. Med. Sci., June 16, 1908, p. 822.... | Cases noted separately. |
| 83 | Matas..... | Op. | M. | .. | Abs. Jour. A. M. A., 1914, lxi, p. 328..... | Extra-appendiceal condition. |
| 84 | Maylard (from Stengel). | Aut. | M. | 69 | Tr. Glasgow Clinic and Path. Soc., 1891, 3, iv, iii. | Gelatinous cyst. |
| 85 | Merkel..... | Aut. | M. | .. | Ergebn. d. Allgem. Path. u. Path. Anat., Abt. 2, vol. 9, s. 329 | Pseudomyxoma peritonei. |
| 86 | Montgomery..... | Op. | F. | .. | Jour. A. M. A., xxix, p. 172..... | Cyst with staphylococci present. |
| 87 | Montgomery..... | Op. | F. | 44 | Jour. A. M. A., xxix, p. 172..... | Hydrops. |
| 88 | Moore..... | Op. | F. | .. | Brit. Med. Jour., 1910, vol. 1, p. 1109..... | Pseudomyxoma peritonei. |
| 89 | Nager..... | Op. | M. | 27 | Ziegler's Beitrage, 1904, Bd. 36, H. I., s. 88.... | Described as a lymphangi-endo- thelioma. |
| 90 | Norris..... | Op. | F. | 60 | Univ. of Pa. Med. Bull., November, 1903, No. 9. | Primary carcinoma. |
| 91 | Noble..... | Op. | M. | 69 | Berlin Klin. Woch., January, 1909, No. 1, s. 15.. | Very large pseudomyxomatous cyst |
| 92 | Oberndorfer..... | Aut. | M. | 64 | Verh. der Deut. Path. Ges., 1906, s. 235..... | Large cyst; contents not described. |
| 93 | Oberndorfer..... | Aut. | M. | 74 | Verh. der Deut. Path. Ges., 1906, s. 235..... | Small gelatinous cyst. |
| 94 | Oberndorfer..... | Aut. | M. | 74 | Verh. der Deut. Path. Ges., 1906, s. 235..... | Small gelatinous cyst. |
| 95 | Ogilvie..... | Op. | M. | 22 | Jour. A. M. A., February 20, 1915, p. 657..... | Pseudomyxoma peritonei. |
| 96 | Pauchet..... | Op. | M. | .. | Gaz. Med. de Picardie, 1900, xviii, p. 146..... | Small gelatinous cyst. |
| 97 | Perkins, I. B.,..... | Op. | F. | 15 | Personal description..... | Pseudomucinous cyst; calcareous walls. Columnar-celled carcinoma. Small mucous cyst. |

CYSTIC DILATATION OF THE VERMIFORM APPENDIX

| | | | | | | |
|------|-------------------------|------|----|----|---|--|
| 98 | Phenister..... | Op. | F. | 31 | Jour. A. M. A., May 29, 1915..... | Large pseudomucinous cyst. |
| 99 | Rathe..... | Op. | F. | 30 | Monatsschr. f. Geburtsh. u. Gyn., 1913, vol. 37, s. 322 | Gelatinous cyst. Pseudomyxoma peritonei. |
| 100 | Ribbert..... | Aut. | F. | 30 | Virchow's Archiv, 1893, cxxxii, s. 66 | Small mucous cyst. |
| 101 | Ribbert..... | Aut. | M. | 19 | Virchow's Archiv, 1893, cxxxii, s. 66 | Small gelatinous cyst. |
| 102 | Ribbert..... | Aut. | M. | 55 | Virchow's Archiv, 1893, cxxxii, s. 66 | Small gelatinous cyst. |
| 103 | Ribbert..... | Aut. | M. | 26 | Virchow's Archiv, 1893, cxxxii, s. 66 | Small gelatinous cyst. |
| 104 | Ribbert..... | Aut. | M. | .. | Virchow's Archiv, 1893, cxxxii, s. 66 | Small gelatinous cyst. |
| 105 | Ribbert..... | Aut. | F. | 70 | Virchow's Archiv, 1893, cxxxii, s. 66 | Small gelatinous cyst. |
| 106 | Roberg..... | Op. | F. | .. | Tr. Chic. Path. Soc., 1908, p. 180..... | Gelatinous cyst. Pseudomyxoma peritonei. |
| 107} | Rokitansky (from | Aut. | .. | .. | Med. Jahrb. Wien., 1867, vol. xiii, s. 179, also | Described as colloid carcinoma. |
| 110} | Stengel) | | | | Handbuch der Path. Anat., iii, s. 184 | |
| 111 | Sissojeff..... | Op. | .. | .. | Virchow's Archiv, July, 1911..... | Small cyst. |
| 112 | Shoemaker..... | Aut. | M. | 60 | Occidental Med. Times, 1892, vi, p. 387 | Gelatinous cyst. |
| 113 | Staubenrauch..... | Op. | M. | 23 | Munch. Med. Woch., 1899, 35, s. 1782 | Small cyst. |
| 114 | Staubenrauch..... | Op. | .. | 19 | Munch. Med. Woch., 1899, 35, s. 1782 | Small cyst. |
| 115 | Stavcy..... | Op. | .. | .. | Discussion of Vaughan's case..... | Mentions small cyst. |
| 116 | Stengel..... | Aut. | F. | 50 | Journ. A. M. A., 1906, 46, p. 495 | Possible colloid carcinoma. |
| 117 | Steincr..... | Aut. | F. | 30 | Referred to by Van Hook..... | Small gelatinous cyst. |
| 118 | Steiner..... | Aut. | .. | .. | Referred to by Van Hook..... | Small gelatinous cyst. |
| 119 | Steiner..... | Aut. | .. | .. | Referred to by Van Hook..... | Small gelatinous cyst. |
| 120 | Steincr..... | Aut. | F. | 55 | Referred to by Van Hook..... | Small gelatinous cyst. |
| 121 | Stimson..... | Aut. | .. | .. | ANNALS OF SURGERY, 1896, p. 186..... | Developmental irregularities. |
| 122 | Stonc, I. S..... | Op. | .. | .. | Discussion of Vaughan's case..... | Small cyst. |
| 123 | Sonnenberg..... | Aut. | .. | .. | Path. u. Therap. du Perityph., Leipzig, 1905..... | Small pseudomucinous cyst. |
| 124 | Tomita..... | Op. | .. | .. | Cent. f. Allg. Path. u. Path. Anat., 1907, s. 849.. | Escape of contents into meso-appendix. |
| 125 | Treves..... | Op. | .. | .. | From Van Hook..... | Gelatinous cyst. |
| 126 | Treves..... | .. | .. | .. | From Van Hook..... | Gelatinous cyst. |
| 127 | Treves and Swallow..... | .. | .. | .. | Lancet, February 9, 1899..... | Mucous cyst. |
| 128 | Trotter..... | Op. | M. | 36 | British Med. Jour., March 9, 1910, p. 681..... | Pseudomyxoma peritonei. |
| 129 | Vaughn..... | Op. | .. | .. | Wash. Med. Annals, Wash., D. C., May, 1911.. | Small cyst. |
| 130 | Vaughn..... | Op. | .. | .. | Observation..... | Large cyst. |
| 131 | Van Hook..... | Op. | .. | .. | Medicine, March, 1896..... | Cyst in hernial sac. |
| 132 | Vimont..... | Aut. | F. | .. | Bull. de la Soc. Anat., Paris, 1887, vol. 62, p. 608 | "Mucocele." |
| 132 | Virchow..... | Aut. | .. | .. | Die Krankhaften Geschwülste, 1863, I, s. 250.... | Cyst size of a fist. "Hydrops." |

| No. | Author | Source | Sex | Age | Reference | Condition |
|-----|---------------------------|--------|-----|-----|---|--|
| 133 | Weinhold..... | Op. | F. | 74 | Monatsschr. f. Geburtsh. u. Gyn., April, 1909... | Large pedunculated cyst. "Slightly turbid contents," probably fluid. |
| 134 | Werthe..... | .. | .. | .. | Archiv f. Gynäk., 1884, 24, s. 100 | Mucous cyst. |
| 135 | Wenzel-Gruber..... | Aut. | .. | .. | Virchow's Archiv, Bd. 63, H. L., s. 98 | Cyst drained by incision. |
| 136 | Wier..... | Op. | M. | 55 | Med. Record, 1880, vol. 17, p. 44 | Cyst drained by incision. |
| 137 | Wier..... | Op. | .. | .. | Refers to similar case | Large mucous cyst. |
| 138 | Wilks (from Stengel)..... | .. | .. | .. | Quoted by Fagge. Tr. on Append., London, ii, p. 174 | Small mucinous cyst. |
| 139 | Wilson..... | Op. | F. | 68 | Lancet, 1912, p. 1498 | Ruptured cyst. |
| 140 | Wood..... | Op. | F. | 52 | Lancet, 1912, p. 1498 | Large hydropic cyst. |
| 141 | Wölfler..... | Op. | M. | 19 | Am. Jour. of Obstetrics, January, 1900, p. 15 | Cyst in hernial sac. |
| 142 | Zdeker..... | .. | .. | .. | Archiv f. Klin. Surg., 1879, xxi, s. 432 Prag. Med. Woch., 1888, xxvii, s. 340 | An empyema. |

MEGACOLON

HIRSCHSPRUNG'S DISEASE—REPORT OF A CASE IN AN ADULT

BY JOSHUA C. HUBBARD, M.D.

OF BOSTON, MASS.

ASSISTANT SURGEON, BOSTON CITY HOSPITAL; ASSOCIATE IN SURGERY, HARVARD MEDICAL SCHOOL

HIRSCHSPRUNG'S disease, ordinarily a disease of infancy and childhood, is described in many of the text-books on surgery as a congenital, idiopathic dilatation of the colon. This is only true when the word "colon" is used in its larger sense as meaning the large bowel. Hirschsprung in his original two cases (*Jahrbuch von Kinderheilk.*, 1887, xxvii) described the dilatation of the sigmoid as more pronounced than that of the colon. Articles by Finney (*Surgery, Gynecology and Obstetrics*, 1908) and Wagner (*Surgery, Gynecology and Obstetrics*, 1906, vi, page 44) are also of cases where in addition to a dilatation of the colon the sigmoid as well was decidedly dilated and hypertrophied.

Neugebauer (*Erg. d. Chir. u. Orth.*, 1913, vol. xvii, 598) in a series of 169 cases found the sigmoid alone involved in 74. Barrington-Ward (*Brit. J. Surg.*, 1914, i, 345) reports 19 autopsies from the Hospital for Sick Children in London in whom all the sigmoids were dilated. Mention is made that even the rectum at times is involved.

The description, therefore, given by Brewer in his *Text-book on Surgery* (1915 edition) is perhaps as concise and satisfactory as any. It reads, "This rare condition, as the name implies, consists of a chronic dilatation of the sigmoid and even of the greater part of the transverse and descending portions of the colon, resulting in an enormous accumulation of fecal matter and gas." It is generally understood (Barrington-Ward) that cases where a definite obstruction is present do not belong under this classification. Occasionally, however, in the literature such a case is reported as one of Hirschsprung's disease. As the condition is of congenital origin, it naturally follows that clinically these cases are usually found in infants and young children. Occasionally some one with possibly a less marked condition grows up and the pathological condition is not recognized until adult life is reached. These adult cases are necessarily more rare. It is, therefore, justifiable to report even an isolated case of such a condition.

In a well-developed case the treatment is almost necessarily surgical. In the cases with less dilatation, it is conceivable that medical

treatment might help. Duval's mortality is 74 per cent. in the cases treated medically and 34 per cent. in those treated surgically in 59 cases; Lowenstein found a mortality of 66 per cent. treated medically and 48 per cent. treated surgically in 44 cases. Terry in 110 cases treated surgically finds a mortality of 25 per cent. (Barrington-Ward).

Neugebauer (*Erg. d. Chir. u. Orth.*, 1913, vol. xvii, 598) reports in 133 cases treated internally a permanent cure in but $1\frac{1}{2}$ per cent.

An ideal treatment is, it seems to me, excision of the dilated portion of the intestine with an anastomosis between normal pieces of the intestine. This is a large operation. It is of interest, however, to know that Lane has done it on five children whose ages were three, six, nine, ten and a half, and twelve years, with the death of only one, not due to the operation but to a slipping of a ligature. Perthes (*Bert. z. klin. Chir.*, 1914, xc, 575) advises removing the dilated portion of the intestine by pulling it down through the anus, cutting it off and doing an anastomosis just beyond the anus. The bowel is then tucked back inside of the anus. This is, he says, applicable to that particular class of these cases where there is a congenital lengthening of the flexure and colon. This allows the colon to be pulled down through the rectum. He has devised a metal button for facilitating this.

Neugebauer believes strongly in resection and gives 56.5 per cent. cure following immediate resection and 90 per cent. cure from operation for resection done in stages. He says that diarrhoea following ileosigmoidostomy is to be but little feared.

Report of Case.—Miss H., twenty-four years old; born in Maine. While an infant, bowels did not move satisfactorily. From then to about ten years of age said to have been all right. At ten had an attack of "stoppage," vomiting, delirium, unconsciousness and fever, with the development of a tumor on the left side. Very sick. In bed a week. Relieved by glycerin enemata. After this attack, bowels were always constipated. Laxatives always necessary. At eleven years another attack, not so bad. Bowels became more and more constipated. Many attacks of stoppage; at least one a year, with vomiting, fever, delirium, pain on left side. The left-sided tumor at this time was always present, even between the acute attacks.

In April, 1908, the appendix was removed. Wound opened up after operation, and a second operation necessary to close it. Treated then for ulcer. Took enemata. Left leg then began to give trouble, difficult to move it. In the summer of 1909 sick



FIG. 1.—Megacolon.



with high temperature and all the symptoms of typhoid, even rose spots. Not considered typhoid, however, for after a few days of pain, fever and delirium the temperature would fall to subnormal, and patient would be all right for several days. The symptoms then would appear again and the temperature rise only to subside again.

It was in October, 1913, that for the first time I saw the patient with Dr. Drowne. At that time, to have a movement enemata had been necessary for two years. Recently the difficulty had increased so that the fluid of the enema was retained and massage was necessary each time to expel it. An X-ray picture (Fig. 1) by Dr. Percy Brown after a bismuth enema showed a dilated and convoluted sigmoid, and dilated descending, transverse, and ascending colons. The patient was incapacitated for work. Medical treatment had been thoroughly tried and had given no great benefit. She was poorly nourished, with poor vitality, and in such a condition that an extensive operation seemed out of the question.

Under nitrous oxide, oxygen, ether sequence, October 10, 1913, the ileum was divided just above the ileocæcal valve. Both ends were closed. The ileum was then fastened to the upper rectum or lower sigmoid by a lateral anastomosis. The sigmoid was then divided just above this anastomosis, the lower end closed and the upper end brought out into the wound. The abdominal incision was then closed, leaving the opening in the sigmoid on the surface. I made this artificial opening to drain the ascending, transverse and descending colons and to prevent any accumulation in fæces here through retroperistalsis at the site of ileosigmoidostomy. Patient stood the operation well, but for the first few days she was very uncomfortable and sick with frequent vomiting. The pulse, temperature, and examination of the abdomen were all negative and the rectal tube found gas and fæces, showing that the anastomosis was functioning.

After the patient had gone home an abscess developed just above the colostomy opening, which at times discharged gas and brownish material. At this time she was eating anything she chose without any distress. Had one to three normal movements a day without any laxatives or enemata.

On April 3, 1914, the abdomen was opened again, the sigmoid and colon back to the cæcum were then removed—a little more than three feet in all. The upper end still contained putty-like masses which appeared to be fæces. A loop of the intestine was found adherent to the abdominal wall under the fecal fistula. This was dissected free from the wall and the opening in it sutured. Patient stood the operation remarkably well.

After this operation the fecal fistula appeared again and since has caused a great deal of bother and required several operations. Now, however (October, 1915), it is closed so that only rarely is there any discharge of gas. The patient has improved steadily so that now she considers herself perfectly well and she looks the picture of health. She has gained in weight and during the last summer she was able to do the housework on a farm employing four men. Her bowels move easily with a small dose of Russian oil.

SIGMOIDOVESICAL FISTULA*

WITH REPORT OF A CASE

BY ROBERT C. BRYAN, M.D.

OF RICHMOND, VIRGINIA

VESICO-INTESTINAL fistulæ are comparatively rare—the sigmoidovesical variety ranking about third in order of frequency. According to Chavannaz they form 24.07 per cent. of all vesico-intestinal fistulæ. Of the 385 cases of enterovesical communications collected by Parham and Hume, in 278 of which the type of fistula is given, there were 33 cases of the sigmoidovesical variety. Our own study is based upon 42 cases which we were able to collect from the literature. The first authentic case is most probably the one reported by Frank in 1786.

Though the condition was known to the ancients, no valuable study of the subject appeared until Blanquinque wrote his thesis in 1870. Following this, Cripps, Chavannaz, Pascal and others contributed excellent studies also. A good review of the topic in the English language was published in 1909 by Parham and Hume. Chavannaz and Herczel report patients who were driven to suicide on account of this affliction, and Rotter states the case of a man who, not being able to obtain employment, on account of the odor about him of constantly decomposing urine and the involuntary expulsion of flatus per urethram, deliberately committed a crime so that he might get himself arrested and thus be assured of board and lodging.

The case which the writer wishes to report was referred March 1, 1915, by Dr. C. M. Scott, of Bluefield, W. Va.

W. C. B., aged forty-eight years, a carpenter; married, with 2 healthy children.

One sister died of tuberculosis, another sister had cancer, otherwise family history is negative.

Patient had typhoid fever at eighteen, contracted gonorrhœa at twenty-three, denies any history of syphilis, and had pneumonia at thirty-eight. The present trouble started about two years ago with pain in the left flank. At times the pain was very severe, particularly when somewhat constipated, so that he soon found out that following the use of a purgative he would feel better. Occasionally there would be 2 or 3 months between attacks, but

* Read before the Medical Society of Virginia, October, 1915.

recently the length has been shortened to two or three weeks, at times the pain becoming so severe that it required the attention of a physician. For years he has had a flat ribbon stool and has had to strain to have an action, requiring large cathartics.

In October, 1914, he noticed that gas and bubbles were present in the urine, which burned some. This has been more pronounced recently, and he now notices not only the bubbles but also hard, black particles. This is invariably the rule when at stool, but not so marked when standing up. Twelve years ago when in Washington he was seized with one of these attacks of pain and a physician was called in who told him he had a stone in the bladder which had cut through to the intestines. This is the patient's explanation of his present trouble.

At times he has been a hard drinker and is an incessant smoker.

Examination shows a rather anæmic man, 5 feet 9 inches in height, weight 150 pounds, the protruding belly and retracted thorax of evident visceroptosis. Skin is flabby and pale. Heart and lungs are normal. Liver not enlarged. No scars on the body; teeth good.

In the left flank a tumor is felt about the size of an egg, which is freely movable, particularly to the middle line, and which gives a little pain on handling. Cystoscopy is unsatisfactory on account of the large amount of mucus and débris which floats in the bladder, but a darkened area is noted in the vertex. The Wassermann reaction is positive ++++. Urinary examination shows no blood, considerable pus, no crystals, no casts, no tubercle bacilli; fæces and *Trichomonas intestinalis hominis* are found. Renal function test showed appearance in 9 minutes, and 20 per cent. for the first hour, and 12 per cent. for the second; total of 32 per cent. Blood count: red blood-cells 4,104,000; white cells 10,000. X-ray by bismuth rectal injection gives immense ballooning of the sigmoid proximal to the stricture, but no communication established with the bladder.

On March 6, under ether anaesthesia, a left low intermuscular operation was performed, sigmoid drawn to the median line and was found to be stuck to the summit of the bladder by a fistulous tract of about $\frac{1}{2}$ inch in length. This was dissected loose, the bladder hole was burned with carbolic acid and alcohol and invaginated with purse-string and reinforced with catgut. A normal Meckel's diverticulum about 3 inches in length was noticed anterior and unattached to the fistula, with its free end pointing upward. This was not disturbed. The small intestines were dissected loose, the rough necrotic hole in the sigmoid was freed, and its edges, made diamond-shaped toward the mesenteric border, were brought together with catgut, reinforced with linen. Drain-



FIG. 1.—Note the Meckel's diverticulum anterior and internal to the fistulous tract, and unattached.



FIG. 2.—Tumor excised. Hole in the bladder and sigmoid inverted and reinforced with silk sutures.

SIGMOIDOVESICAL FISTULA

age instituted and catheter inserted for 3 days. The patient did well for 5 days, developed suppression of urine, and died March 11, 1915.

Sex.—Of the two sexes, man is much more frequently affected than woman, the ratio being, according to Pascal, about 3 to 1. Of our 42 cases 27 were males, 14 females and 1 sex not given.

Age.—The age factor was represented in our own cases as follows:

| | |
|-------------------------------|----|
| Age not given | 6 |
| Between 20 and 30 years | 3 |
| Between 31 and 40 years | 7 |
| Between 41 and 50 years | 5 |
| Between 51 and 60 years | 14 |
| Between 61 and 70 years | 4 |
| Between 71 and 80 years | 2 |
| Between 81 and 90 years | 1 |

42

Etiology.—The rarity of accidental traumatic sigmoidovesical fistulæ may well be surmised when one remembers how rare traumatic injuries to the pelvic organs are.

Pascal's classification has largely been adhered to in the literature. It serves the purpose well but should include under the non-traumatic inflammatory variety diverticulitis and amœbiasis, as cases of this etiologic nature have been reported. Thus:

(1) Traumatic: (a) Accidental; (b) surgical.

(2) Non-traumatic: (a) Inflammatory, including abscess, stricture, stone, ulcer, diverticulum; (b) malignant; (c) tuberculous; (d) syphilitic; (e) actinomycotic; (f) amœbic.

In connection with this etiologic classification one may speak of vesico-intestinal fistula originating in the bladder, in the intestines, or in the neighboring organs. As is well known the most common seat of diverticulitis is in the neighborhood of the sigmoid flexure. Heine deserves the credit for calling especial attention to this phase of the subject.

Pathology.—An illustration from recent literature of the difficulties of positive diagnosis is that reported by Parham in 1909. His case was believed to be by the author an inoperable malignant condition, and a palliative colostomy was performed. Thirteen years later the patient was reported as doing well, a circumstance which led the author to hint that the case might have been one of sigmoid-diverticulitis. We are inclined to believe with Chute that the latter diagnosis was in all probability the correct one. Whatever convictions concerning the

etiology of this condition one may have gained from reading the literature on vesico-intestinal fistulæ in general, it appears well substantiated that diverticulitis is the most frequent cause of sigmoidovesical fistulæ. From the reported cases our etiological table resolves itself into the following:

| | Cases |
|---------------------------------------|-------|
| Sigmoid diverticulitis | 15 |
| Probable sigmoid diverticulitis | 6 |
| Inflammation (?) | 4 |
| Surgical traumatism | 3 |
| Carcinoma of sigmoid | 3 |
| Carcinoma of bladder | 2 |
| Carcinoma not specified | 2 |
| Ovarian abscess | 2 |
| Amœbic sigmoiditis | 1 |
| Carcinoma or gumma of sigmoid | 1 |
| Tuberculosis | 1 |
| Stricture | 1 |
| Ulceration | 1 |

42

Apparently 22 out of the 42 cases were due to a diverticulitis of the sigmoid with subsequent adhesion to bladder and fistulous formation.

The Etiology of Diverticula and Fistulous Diathesis.—As has been stated, Heine was one of the first to devote a special study to the subject in his thesis of 1904. An excellent and very exhaustive study in the English language was published by Maxwell Telling in 1908. The etiology of diverticula of the lower bowel is still obscure. It occurs usually in advanced age, is more common in males than in females, and obese persons seem to be more predisposed. The structure of the sigmoid and its physiological function, namely, the more or less prolonged retention in this part of the gut of accumulated fæces which exert pressure upon the lumen, have been advanced as causes. Louis B. Wilson sums up his study as follows: "It may be stated briefly that diverticula of the lower bowel, while frequently following the course of vessels, probably owe their origin more to congenital weakness of the circumferential musculature than to any other factor.

According to Mayo-Griffin the clinical diagnosis of diverticulitis cannot be made positively. Left-sided pain low in the abdomen (a circumscribed peritonitis), coming in spells and associated with constipation, brings it to mind. In view of the apparent frequency of the affection, this etiologic factor should always be borne in mind in all sigmoidovesical fistulæ. Failure to recognize the condition has led on

SIGMOIDOVESICAL FISTULA

more than one occasion to the abandonment of operation when radical work might have cured the patient.

To quote Telling, "diverticula themselves are buried in a mass of hardened fibrous tissue which very frequently produce secondary adhesions to adjacent viscera. This leads to the mimicry of carcinoma. Many times the tumor has been dealt with under this mistaken diagnosis, such specimens being found in museums labeled 'carcinoma.'"

From the anatomical relationship of the parts, it is obvious that an adhesion between a peridiverticulitis and the bladder will be likely to occur. When it is remembered that such adhesions occur at the end of a pouch which has fecal contents, and which pouch may at any time become perforated and give rise to a suppurative process between the inflammatory sigmoid mass and the bladder wall, it is simply following the course of an appendix which ruptures into a hollow viscus. The fistulous communication is often a narrow and tortuous tract which tunnels a considerable thickness of inflammatory fibrous tissue or more rarely has an immediate anastomosis. Chute discusses at length the mechanism of diverticula formation. He thinks the actual cause of these diverticula is probably an increased pressure in the bowel due to constipation or an increased formation of intestinal gas. He believes that the most probable predisposing factor is the one suggested by Bland-Sutton, namely, that there is often a fatty infiltration of the bowel wall just under the epiploic appendages that weakens it at this point. "Once a pouch has formed, it becomes filled with stagnant bowel contents. Since there is practically no muscle fibre in the wall of the diverticulum, and as its entrance into the bowel is smaller than its distal end, we have present all the necessary factors for a diverticulitis." It is interesting to note in the writer's case the Merkel's diverticulum lying anterior to the union and unattached.

Mayo sums up his clinical observations of acquired diverticulitis of the large intestines as follows: "All the patients coming under observation have had certain features in common. They were over forty-five years of age; all but four were males and, excepting for this illness, were otherwise in robust health, most of them inclining to obesity. The onset of the symptoms was sudden, and presented the characteristics of a localized peritonitis. A tumor rapidly developed, and usually lay to the left of the median line, in the middle or lower quadrant of the abdomen." Concerning the part of the bowel affected Heine's study is of interest. In eight cases collected by him of vesico-intestinal fistulæ due to diverticulitis, the diverticulum was located in the sigmoid flexure in seven instances and once in the rectum.

Symptoms and Diagnosis.—The diagnosis of vesico-intestinal fistulæ should not be difficult. Vastly more important is the decision as to what part of the intestinal tract is involved in the fistula. The cardinal symptoms of all vesico-intestinal fistulæ are: (1) passage of gas by urethra; (2) passage of fæces by urethra; and (3) passage of urine by rectum. Chute states that if the bowel contents found in the urine is dark and contains solid particles, it may be assumed that the connection is probably with the small intestines. On the other hand, Dittel does not think that we can obtain as much aid from the chemicomicroscopic examination of the urine as from a more delicate balancing of all the clinical manifestations and the history of the case.

Long standing complaints referable to the gastro-intestinal tract, such as chronic constipation, areas of local tenderness, transitory attacks suggestive of local peritonitic processes, will point to the intestines as the probable origin of the fistula. Conversely, long standing bladder affections, especially conditions involving ulceration of bladder wall, indicate that this organ gave rise to the fistulous communication. Localized pain in left lower abdomen and signs such as have been mentioned in connection with diverticula will point to a sigmoid diverticulitis as the etiologic factor. The specific state and Wassermann and luetin tests should be valuable diagnostic aids. X-ray, bismuth injections, cystoscopy and proctoscopy should be carried out in all suspected cases.

The symptomatology of this affection is uniform in the cases reported. The majority showing as the most constant and annoying single symptom a pneumaturia, which is not only accompanied by an odor, but on escaping may be heard some distance from the patient. According to Parham and Hume pneumaturia may occur after (1) instrumental vesical manipulation, litholapaxy, etc.; (2) in certain neuropathic conditions; and (3) in glycosuric conditions, the decomposing urine containing sugar. The exclusion of any of these conditions should, however, not be difficult in the presence of other symptoms, such as passage of fecal matter per urethram and urine by rectum. The last named symptom is only present, according to Chavannaz, in one-third of the cases, a circumstance which is readily appreciated when it concerns communication with some part of the bowel higher up. Next in importance are the painful tenesmus and symptoms of cystitis. The development of this is insidious, and these indefinite symptoms continue until the patient suddenly finds himself passing gas per urethram, or more rarely notices urine expelled by the rectum.

SIGMOIDOVESICAL FISTULA

Prognosis.—Aside from the local symptoms the general condition of the patient suffers a great deal in most cases. Mental anxiety, insomnia, loss of weight and exhaustion are common phenomena, which invalidate the unfortunate for work. In rare instances no general disturbances of health occur and the patients live for many years apparently not much the worse for the affection. The average duration of life, however, according to Pascal's statistics is three years.

Of our 42 cases of sigmoidovesical fistula, 30 died, 9 recovered, 2 improved and in 1 the result is not given. The prognosis is therefore grave. Only 1 case recovered spontaneously. Of Pascal's 300 cases of enterovesical hiati, 19 recovered spontaneously, 15 recovered under expectant treatment, and 24 were cured by operative measures. The prognosis is best in the traumatic variety. Of the 3 cases in our series, 2 recovered following operative interference. Next comes the inflammatory variety. The tuberculous and carcinomatous varieties are the least favorable.

Complications.—Aside from the immediate symptoms certain serious complications may ensue from a fistulous communication between the bladder and intestines. Among these must be mentioned ascending renal infection, which occurred 18 times out of 250 cases of Pascal's table. Fourteen times the infection was bilateral. The relative rarity of this complication is explained by Chavannaz on the theory that the bladder in its battle with infection usually maintains the upper hand, and Heubner states that the colon bacillus is less harmful when it enters the bladder direct than when it gains access per urethram.

A rarer complication is calculus formation in the bladder as a result of the passage of fecal matter into this organ. The effect of the passage of urine into the bowel depends largely upon the state of the urine. Undecomposed urine has no deleterious effect upon the intestinal mucosa and considerable amounts may be absorbed. Decomposed urine, on the other hand, causes an inflammatory condition with resultant diarrhoea and painful tenesmus.

Treatment.—Vesico-intestinal fistula is essentially surgical. The older writers have reported cures from purely medical treatment. These were doubtless specific cases in which mercury and iodides were used. But this was when a laparotomy was a vastly more serious proposition than it is to-day. Whatever the statistics may show with reference to the value of medicinal treatment alone in vesico-intestinal fistula, the 9 recoveries and 2 improvements recorded in our 42 cases of sigmoidovesical fistulæ were due in every instance except one to surgical interference. The 1 case recovered spontaneously. There are cases in

which operative procedure is contra-indicated, either because of the general condition of the patient or because of the nature of the etiologic factor. In these instances medicinal treatment may be of benefit.

The surgical treatment resolves itself into (1) palliative and (2) curative. Under palliative treatment Parham and Hume suggest the removal of stone by lithotomy or lithotripsy, the dilating of strictures, colotomy and colostomy, suprapubic cystotomy, intestino-anastomosis and lumbar transplantation of the ureters or by perineal or vaginal attack when the communication is low. These authors caution that when colostomy is decided upon it is necessary that it should be done so as to fulfil two conditions. First, it must be above the fistula, second, it must be complete, so as to have no connection between the upper and lower segment of the intestine. Colostomy was very much more in vogue formerly than it is now, and it appears that its most useful place in the treatment of this condition is as a preliminary procedure to a radical closure of the fistula introperitoneally. Used in this way it may improve the chances of success for a subsequent radical operation. In our 11 cases of recovery and improvement, colostomy was responsible for only one recovery and the two improved cases. The radical operative procedure is best accomplished by the inter-abdominal separation of the sigmoid and bladder and suture of the openings. Concerning the failure of this method in his two cases Chute says, "Beside the technical difficulty of doing a plastic operation in the depths of the pelvis, there are two other things that militate against success in closing these diverticular openings in the sigmoid. The first is the frequency with which there is a narrowing of the sigmoid below the opening of the diverticulum, which increases the pressure on the suture line, and if this narrowing is marked, makes success practically impossible. Such a narrowing may be due either to an infiltration of the bowel wall with secondary contraction of the lumen, or to the pressure of a mass of inflammatory exudate against the bowel from the outside. The other factor that renders success difficult in these cases is the poor condition of the bowel for suture. It is thickened, making folding in of the wall practically impossible; it is friable, making it difficult to have sutures hold; and finally, its nourishment is interfered with to a degree that makes union slow and uncertain."

Thorough resection of the diseased segment of sigmoid, end-to-end anastomosis and free drainage should remove this obstacle. Westhoff excised the sigmoid in a female forty-three years of age with recovery. Short circuit lateral anastomosis as was done successfully by Sauther may also be considered.

SIGMOIDOVESICAL FISTULA

Cunningham, in a recent article reviewing the literature of rectovesical and enterovesical fistulæ, reports 342 cases and states that the most common location of the opening is in the rectum, nearly 50 per cent. of all cases being formed here, and that the next most common location is in the sigmoid. Cunningham prefers the operation by abdominal section, which, as he says, gives not only the best approach, but is suitable also to the traumatic and inflammatory types and is the method of choice in the malignant or tuberculous states.

BIBLIOGRAPHY

- ¹ Heine, Walter: Über Darmblasenfisteln infolge von Darmdivertikel. Inaugural Dissertation, Leipzig, 1904.
- ² Chavannaz: Des fistules vesico-intestinales acquises chez l'homme. *Annals des maladies des organes genito-urinaires*, 1897.
- ³ Herczel, E.: Beiträge zur oper. Behandlung der Blasen-Mastdarmfistel. *Beiträge zur klin. chir.*, Bd. v, Hft. 3.
- ⁴ Rotter, J.: Die operative Behandlung der Blasendarmfistel beim Manne. *Arch. f. klin. chir.*, Bd. 31.
- ⁵ Blanquique: Etude sur les fistules vesico-intestinales. Thèse de Paris, 1970.
- ⁶ Cripps, H.: The Passage of Air and Fæces from the Urethra. J. & A. Churchill, London, 1888.
- ⁷ Pascal: Thèse de Paris, 1900.
- ⁸ Parham and Hume: Vesico-intestinal Fistulæ. *ANNALS OF SURGERY*, vol. v.
- ⁹ Frank: Cited by Pascal.
- ¹⁰ Chute, A. L.: *Trans. Am. Ass. Genito-Urin. Surgeons*, N. Y., 1911, vi, 86-98.
- ¹¹ Telling, Maxwell: *The Lancet*, vol. i, 1908.
- ¹² Wilson, L. B.: *ANNALS OF SURGERY*, vol. liii, 1911.
- ¹³ Mayo-Griffin: *Surgery, Gynæcology and Obstetrics*, vol. v, 1907.
- ¹⁴ Telling, Maxwell: *The Proctologist*, vol. v, No. 1.
- ¹⁵ Dittel: Dinndarmlasenfisteln, *Wiener med. Wochenschrift*, No. 10-12, 1881.
- ¹⁶ Heubner: *Berliner Klin. Wochenschr.*, November 30, 1899.
- ¹⁷ Cunningham, J. H.: Retrovesical and Enterovesical Fistulæ. *Surg., Gynæc. and Obstet.*, vol. xxi, No. 4.

SIGMOIDOVESICAL FISTULÆ

| No. | Year | Author | Sex | Age | Cause | Treatment | Result | Duration |
|-----|---------|----------------------------|--------|-----|---|--|-------------------------|-----------------------|
| 1 | 1786 | Frank | Male | 73 | Sigmoid diverticulitis | Not given | Autopsy | Several months. |
| 2 | 1820 | Rabouam | Female | 24 | Inflammation | Not given | Autopsy | One month. |
| 3 | 1826 | Boyer | Male | 60 | Sigmoid diverticulitis | Laparotomy | Death | Several months. |
| 4 | 1831-32 | Salmon | Female | 59 | Sigmoid diverticulitis | Palliative medicinal | Autopsy | Five months. |
| 5 | 1836 | Mercier | Male | 76 | Inflammation | Not given | Death | Not given. |
| 6 | 1842 | Tavernot | Male | 65 | Cancer | Not given | Death | Not given. |
| 7 | 1853 | Simpson | Female | .. | Abscess ovary | Not given | Autopsy | Not given. |
| 8 | 1856 | Malcolm | ..... | .. | Tuberculosis | Not given | Autopsy | Not given. |
| 9 | 1858 | Sidney Jones | Male | 64 | Sigmoid diverticulitis | Not given | Autopsy | Ten months. |
| 10 | 1859 | Hulke | Male | 57 | Chronic sigmoiditis around numerous diverticula | Not given | Autopsy | Two and a half years. |
| 11 | 1861 | Tangel | Male | 56 | Sigmoid diverticulitis | Colostomy | Autopsy | (?) |
| 12 | 1866 | Holmes | Male | 51 | Sigmoid diverticulitis | Colostomy | Autopsy | Not given. |
| 13 | 1869 | Maunder | Male | 59 | Ulceration | Colostomy | Death | Not given. |
| 14 | 1871 | Heslop and Simpson | Female | .. | Ovarian abscess | Not given | Autopsy | Over a year. |
| 15 | 1874 | Morison | Male | 50 | Sigmoid diverticulitis | Palliative | Autopsy | Four years. |
| 16 | 1877 | Bruchet | Male | 67 | Stricture | Not given | Autopsy | Not given. |
| 17 | 1889 | Hermanides | Female | 36 | Inflammation | Not given | Spontaneous cure | Five months. |
| 18 | 1889 | Herczel | Male | 48 | Sigmoid diverticulitis | Laparotomy and colostomy | Autopsy | Six months. |
| 19 | 1890 | Battistini | Male | .. | Not given | Colostomy; irrigation | Great improvement | |
| 20 | 1894 | Heuston | Male | 35 | Carcinoma of intestines | Laparotomy | Death | Four days. |
| 21 | 1894 | Peron | Male | 36 | Carcinoma of sigmoid | Laparotomy | Autopsy | Not given. |
| 22 | 1897 | Schwartz | Female | 28 | Inflammation | Laparotomy | Improvement, then death | |
| 23 | 1897 | Gennoville | Male | 61 | Sigmoid diverticulitis | None | Autopsy | Two years. |
| 24 | 1898 | Kelly and Callum | Female | 60 | Sigmoid diverticulitis | Laparotomy | Recovery | Two years. |
| 25 | 1898 | Taffier and Dumont | Female | 52 | Carcinoma of sigmoid | Laparotomy | Autopsy | Not given. |
| 26 | 1900 | Savariaud quoted by Pascal | Female | 40 | Abdominal operation, surgical injury | Resection and erroneous union; laparotomy; resection | Autopsy | Not given. |
| 27 | 1902 | Hepner | Female | 64 | Sigmoid diverticulitis | Laparotomy | Recovery | Fourteen months. |
| 28 | 1902 | Cherny quoted by Waldvogel | Male | .. | Sigmoid diverticulitis | Colostomy | Autopsy | Not known. |
| 29 | 1902 | Waldvogel | Male | 35 | Sigmoid diverticulitis | Palliative | Autopsy | Fifteen years. |
| 30 | 1904 | Hcine | Female | 59 | Perisigmoiditis around numerous diverticula | Laparotomy | Recovery | One year. |
| 31 | 1906 | Royster | Female | 22 | Surgical traumatism | Laparotomy | Recovery | One year, plus. |
| 32 | 1907 | Mayo and Griffin | Male | .. | Probably diverticulitis | Not known | (?) | (?) |

SIGMOIDOVESICAL FISTULA

| | | | | | | | | |
|----|------|------------------|--------|----|-------------------------------|-------------------------------------|--|----------------------------|
| 33 | 1907 | Mayo and Griffin | Male | 51 | Probably diverticulitis | Laparotomy | Good result; persistent fecal fistula; | (?) |
| 34 | 1907 | Westhoff | Female | 43 | Surgical traumatism | Excision of sigmoid | Recovery | Ten years. |
| 35 | 1908 | Pennington | Male | 43 | Carcinoma of rectum sigmoid | Colostomy and suprapubic cystostomy | Autopsy | Six weeks. |
| 36 | 1909 | Parham and Hume | Male | 48 | Sigmoid diverticulitis | Colostomy | Improved | Thirteen years. |
| 37 | 1911 | Sauther | Male | 57 | Carcinoma or gumma of sigmoid | Short circuit; later anastomosis | Recovery | (?) |
| 38 | 1911 | Chute | Male | 53 | Sigmoid diverticulitis | Laparotomy | Death | Five or six years. |
| 39 | 1911 | Chute | Male | 60 | Sigmoid diverticulitis | Laparotomy | Autopsy | Fifth day after operation. |
| 40 | 1912 | Boehm and Dean | Male | 84 | Carcinoma of bladder | Not stated | Autopsy | Seven months. |
| 41 | 1912 | Boehm and Dean | Female | 40 | Carcinoma of bladder | Excision of sigmoid | Autopsy | Two years. |
| 42 | 1912 | Levison | Male | 38 | Amoebic sigmoiditis | Colostomy | Recovery | Several weeks. |
| 43 | 1914 | Bryan | Male | 48 | Syphilitic | Excision | Death | Two years. |

A STITCH TO ASSIST IN THE CLOSURE OF THE POSTERIOR SHEATH OF THE RECTUS ABOVE DOUGLAS'S SEMILUNAR FOLD

BY NATHAN W. GREEN, M.D.

OF NEW YORK

ATTENDING SURGEON TO THE CITY HOSPITAL

It must frequently have been the lot in the experience of every surgeon to find that the distention of the intestines greatly hampered the drawing together of the peritoneum and fascia in the upper abdomen. This is especially true in paramedian incisions. Failure to properly draw these structures together has resulted in imperfect union of these important layers and in unsatisfactory repair of the abdominal wall in this region. It will be remembered that the upper two-thirds of the abdomen is harder to close than the lower third on account of the intimate association of the peritoneum with the fascial structures, the fibres of which run in a general way across the body. Frequently an ordinary running stitch will show a tendency either to pull out or to slit the fascia in the direction of its fibres at each stitch hole. A mattress stitch holds no better.

It was in an effort to overcome this tendency of the suture to split the fascial fibres that I fell upon the stitch here described. I make no claim at originality in it, but I have never read of its being used, and a number of men to whom I have shown it during the past year and a half have never seen it before.

It may be either an interrupted (Fig. 1) or a continuous stitch (Fig. 2). The principle upon which it operates is that of a tendon suture which grasps a fasciculus of the tendon with a loop, and the tighter it is drawn the tighter it holds this fasciculus. A glance at these illustrations will show the method of its operation. The application of it is as follows: The needle is put through the posterior layer of the internal oblique and the transversalis aponeurosis, transversalis fascia and peritoneum with one stroke; then brought out with another stroke, including some fasciculi of this combined aponeurosis; then it is returned again through the first hole and brought out again through the second hole, so that we have a complete loop surrounding these fasciculi; it is then brought across to the other lip of the wound and put through in a similar manner, placing the first puncture opposite to

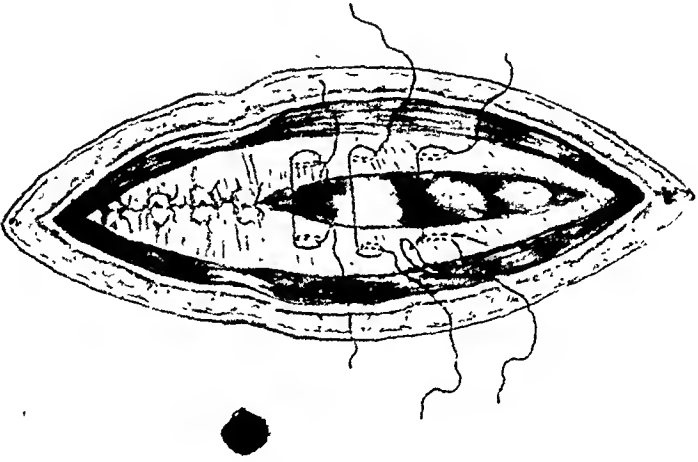


FIG. 1.—Interrupted stitch.

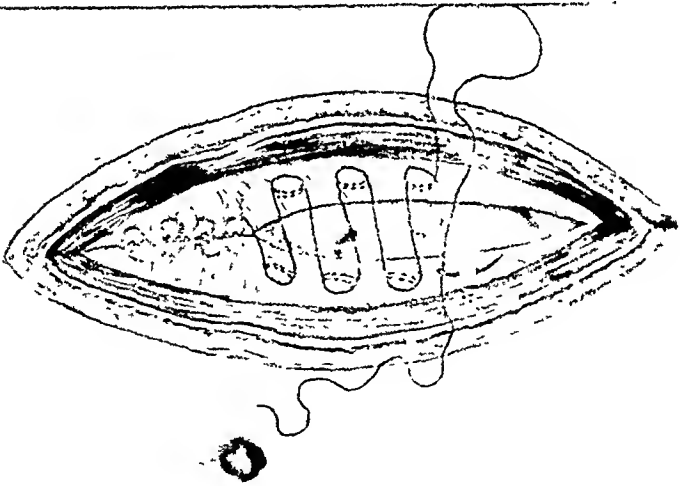


FIG. 2.—Continuous stitch. It shows the lower part of the wound drawn up tightly, and the upper few stitches placed loosely, ready to be "jaiced" up.

CLOSURE OF POSTERIOR SHEATH OF RECTUS

the last puncture of the other side. The ends are then tied with the ordinary first half of a square knot, and as these are pulled up the slack between the two loops is drawn up easily. The tighter it is tied the tighter will the loops around the bundle of fascia and peritoneum hold. The second half of the square knot completes the interrupted stitch. Plain catgut, chromic-gut or kangaroo tendon should be used, as it slips through the tissues readily when the stitches are drawn up. For the continuous stitch, the same procedure is done without tying between the stitches, and at the completion of each half of the stitch the slack is pulled up.

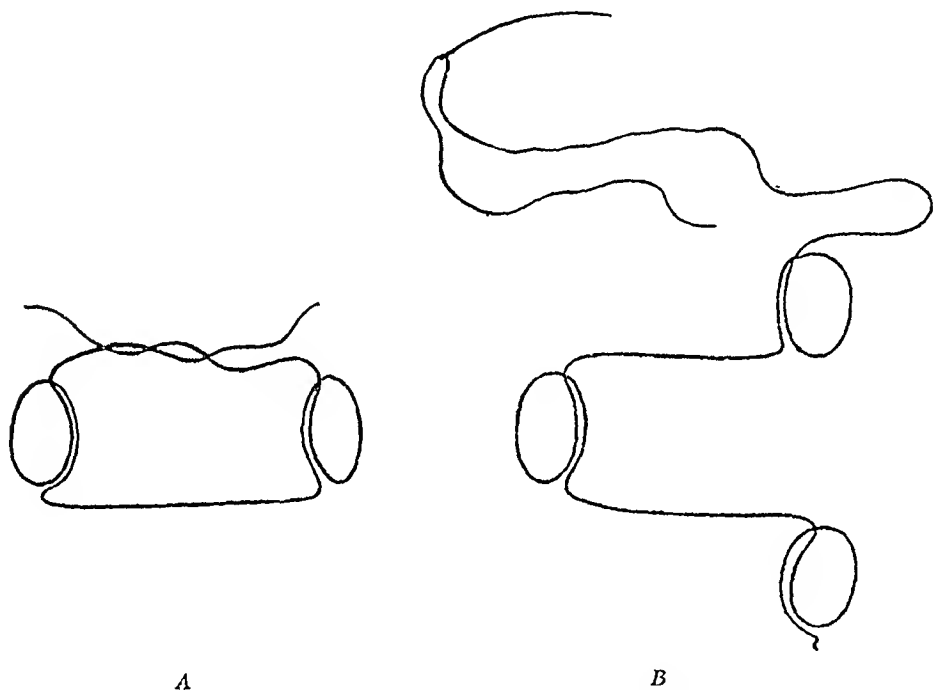


FIG. 3.—A, interrupted stitch; B, diagram of continuous stitch.

I am indebted to Dr. H. H. M. Lyle for a suggestion which I think is valuable. It is to begin the stitch from the peritoneal side and finish it on that side, so that the peritoneum is everted rather than inverted at its completion. This modification is applicable when there is but little tension, but in the presence of great tension I think the original way, *i. e.*, inverting the peritoneum and approximating the fascia, as is shown in the illustration, is the more feasible. I have used it in a number of cases and find that it works in a satisfactory manner.

ARTIFICIAL IMPACTION OF HIP FRACTURE*

BY FREDERIC J. COTTON, M.D.

OF BOSTON, MASS.

VISITING SURGEON TO THE BOSTON CITY HOSPITAL

OUR ordinary treatment of hip fractures has been dominated by two dicta: First, "You must treat the patient, not the fracture"; second, "You must not break up the impaction."

There is some truth in each of these statements, but in practical effect the influence of both pronouncements is bad. It is another case of the "dead hand" of traditional practice hampering present action.

Everyone who has taken pains to study his own hip fractures, or those of others, knows that lamentable results are common. Need they be common? Need the man or woman between forty and seventy, with a broken hip, look forward to a heavy chance of permanent uselessness? All things considered, one could hardly expect restoration of full activity in older patients, but loss of all practical weight-bearing function (often as a result of total non-union) seems too "poor" to put up with.

There is a vast literature on hip fractures; nearly all of it rather footless. Between Astley Cooper and Royal Whitman, I know of nothing worth while, save a paper by Newton Shaffer on work done about 1886.¹

Cooper recognized the important classification but did nothing toward securing results. Whitman has something real, contributing to the attainment of real results along the lines Shaffer first laid down, but he would be in a stronger position if he had differentiated his cases into the two great groups.

The same is true of Maxwell, Phillips and Ruth—each of them has in turn demonstrated certain excellent results of the traction method each has employed; results inconclusive because not classified between the two great groups.

The fact is that hip fractures in adults are divisible into two classes:

1. Fractures at the base of the neck ("extracapsular fractures"), which are going to unite anyhow, with good or bad treatment; which may show great deformity and consequent disability, but practically never fail to unite.

2. Neck fractures proper (intracapsular fractures) in which the

* Read before the American Surgical Association, June, 1915.

¹ N. Y. Med. Journal, October 23, 1897, vol. lxii, p. 557.

ARTIFICIAL IMPACTION OF HIP FRACTURE

proximal fragment (the head) may be mobile, and is always ill-nourished and ill-fitted for any share in the necessary repair.

These neck fractures proper may be impacted, or merely entangled, or loose. The loose fractures *never* unite under routine treatment, so far as I can learn. The loosely impacted fractures are rather apt to loosen up and to show results like those of fractures originally loose. The well-impacted fractures unite by bone, often with tolerable function, though the eversion unusually present is a serious factor in disability.



FIG. 1.—The first case: before impaction; after impaction; the final result. The result was rather good, but bony union uncertain.

Sometimes in these cases the shortening and coxa vara also are sufficient to entail further disability.

In the past the successful cases have been those of extracapsular fractures² which always unite, or those firmly impacted in fair position.

Years ago there came to me the idea of aiding nature by producing



FIG. 2.—First plate: sent out as impacted; sent back as re-fractured. See second plate. At this time patient was seen and presently was re-impacted under ether. Third plate shows results of re-impaction about two months later. Clinical result excellent.

impaction in loose fractures, carrying out by remodelling and re-impaction in cases primarily impacted, but impacted in such poor shape, anatomically, that reduction and re-impaction are greatly to be desired.

The idea of artificial impaction is a new one, I think, never carried

² For example, in Ruth's remarkable collection of 7 post-mortem specimens, to be noted later.

out previous to the cases I reported in the *American Journal of Orthopaedic Surgery*, in May, 1911.

Briefly, it comes to this. Unimpacted fractures of the femoral neck proper never unite by bone; well-impacted fractures do so unite, almost always. Obviously the conversion of cases of the first into

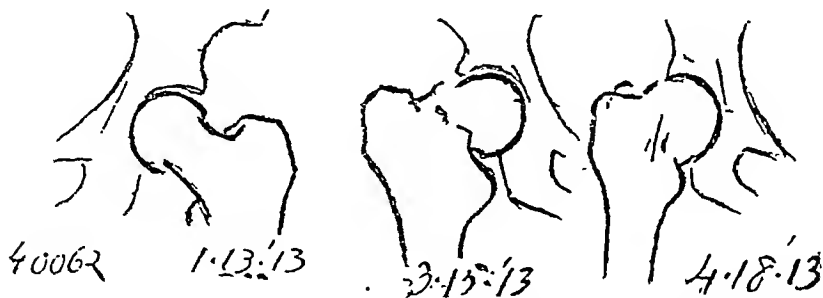


FIG. 3.—Loose fracture with much displacement shown in an X-ray now lost; ether reduction; re-impaction. The plate shows the position after operation. The re-impaction held and all went well until 7 weeks later, when the patient "went bad" and presently died, apparently of myocardial degeneration and consequent heart failure.

FIG. 4.—Woman, aged seventy-nine years; loose fracture. Seven years ago fracture of the other hip. Loose fibrous union with tolerable usefulness resulted. The second lesion is here shown; before and after treatment. Bony union was secured, but owing to her advanced age, to the defective function of the other hip and to some stiffness, she walks poorly but *can* walk.

cases of the second class is extremely desirable. Can it be done? I assert that it *can* be done; that it can be done without damage and without great difficulty, and can be done at any time within a fortnight at least, whether we are dealing with a fracture thoroughly loose when we first see it, with one which has loosened up in the first fortnight,

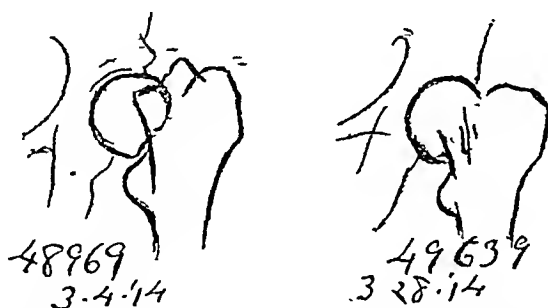


FIG. 5.—Before and after treatment. This was a loose fracture. The re-impaction held up to the last note. I have not traced this case to an end-result.

or with one in which we have deliberately sacrificed the original impaction to secure improved position.

The breaking up of hip fractures is far from new. I saw it done when I was a house officer, but the attempt to establish or re-establish a condition of impaction I believe to be entirely new and its possibility rests, to date, entirely on the data I have here. There are 21 cases

ARTIFICIAL IMPACTION OF HIP FRACTURE

with 1 failure and 1 prospective failure. The first case was impacted no August 31, 1909.

Of these cases treated by the same technic, 4 proved to be extra-capsular fractures. In fractures of this type, the impaction procedure can give at best merely an easier fixation, and is probably no better

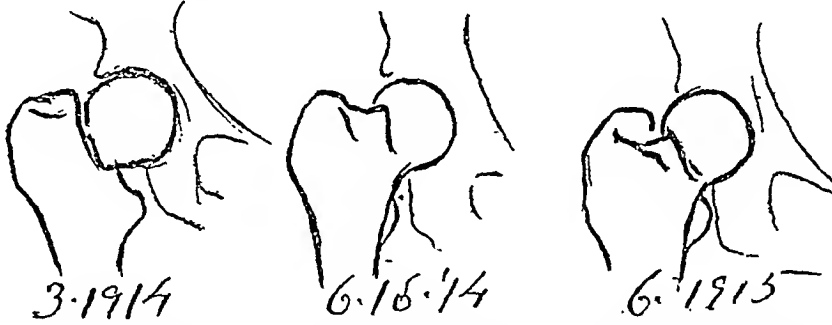


FIG. 6.—The first plate shows the fracture, unimpacted or at best loosely impacted; there was crepitus. The second plate shows the result shortly after reduction and mallet impaction. The third picture shows the end-result, after a year; slight shortening of the neck, but firm bony union. She has practically perfect motion and walks without a limp, unless much fatigued.

method than Whitman's simple abduction in these cases; probably not as good a method as the Phillips-Maxwell-Ruth method of longitudinal and lateral traction. Ruth has, or had recently, 7 post-mortem specimens showing admirable results by this method. All, or at least all save one debatable specimen,³ were definitely extracapsular. I think this method probably the best for this type of cases; it seems illogical and is certainly unproved as to fractures of the femoral neck proper.

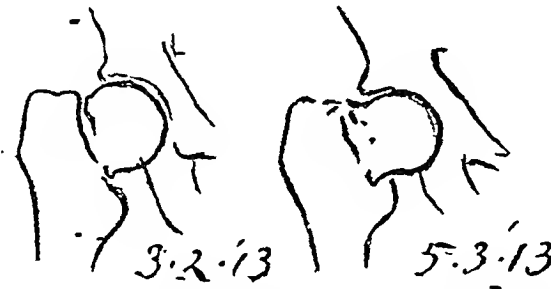


FIG. 7.—A loose fracture in a man of forty years. The first plate before and the second after impaction. He has returned to active work with excellent function. Not traced as yet, as to details of the end-result.

I do not wish to be taken as advocating forcible impaction in all cases, even of neck fracture proper. Not a few of such cases are simply cracks. Many show a sufficient accidental impaction, with deformity in adduction and eversion not great enough to warrant any interference. Some, of course, that show deformity enough to render correction desirable, are poor surgical risks.

³ Obscured by osteo-arthritic changes.

Here and there even loose fractures must be neglected because of the risks imposed by age, by heart lesions, by chronic pulmonary damage (usually bronchitic), by diabetes, etc., though the proportion of such non-surgical cases is apt to be over-estimated.

What I do maintain is that in all cases of loose fracture, in all cases in which impaction gives way, in all cases in which adduction and eversion deformity promise definitely poor results, the procedure herewith given is indicated, and should be carried out unless there are definite contra-indications.



FIG. 8.—Before and after reduction and impaction. Left the hospital with a solid hip. End-result to be traced.

The technic I have followed is this:

First anæsthetize the patient—not deeply—and put him on the table; preferably a Hoffa table, though even an ordinary wooden table will do. After measuring the length, drag the leg down (with your stockinged foot in the perineum) till the length comes out even, and until rotation gives definite slight crepitus; then correct any eversion deform-



FIG. 9.—Before reduction; a loose hip fracture; second plate, after reduction; third, before discharge. What happened in this case I do not know. I operated on a case referred in consultation and have no data as to after-care, save the plates. This I call one of the failures!

ity present; give the leg to an assistant; have another assistant give counterpressure on the opposite side of the pelvis; pad the trochanter with two thicknesses of saddler's felt and pound on it with a very large wooden mallet, till there is a sensation of "giving." The blow should be a slow swinging "following" blow, and the "giving" is very definitely felt in most cases. Then one should test the fact of impaction by the loss of mobility in rotation when the leg is released.

Fig. 12.—Before operation.

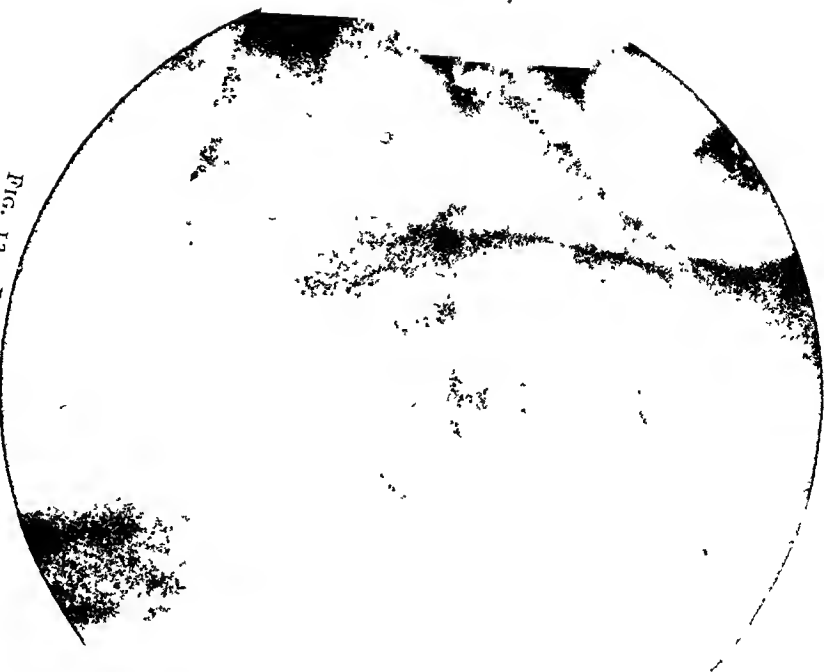


Fig. 13.—After impaction. In abduction plaster. Bony union. Clinical result excellent.





FIG 14 —Four months after forcible reduction for extreme eversion and shortening and the usual mallet impaction and spica plaster Bony union, and the patient now (six months) walks without pain and almost without a limp.

ARTIFICIAL IMPACTION OF HIP FRACTURE

When the job is properly done, this loss of mobility is perfectly definite and rather striking. After impaction, the length of the two legs should come out very nearly even.

After all this is done, I put the leg up in an abduction spica of plaster. Abduction prevents adductor contracture, often troublesome in the period of re-establishment of function. It neutralizes the tendency

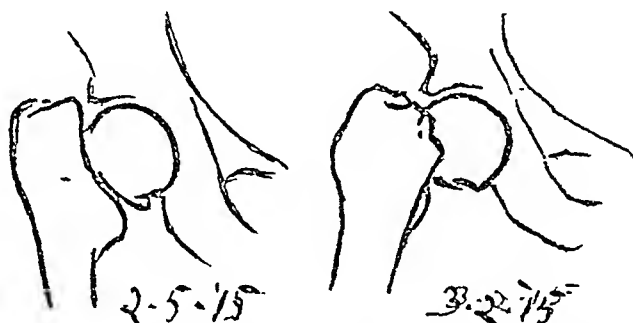


FIG. 10.—An old case of tabes. Hip shown before and after treatment. The fracture was unimpacted in the beginning. The artificial impaction held and bony union was secured; but the clinical result is that conditioned by the original tabetic condition.

to coxa vara from muscle-pull, and is a more convenient position in respect to the bed-care of the patient. In general, abduction is the optimum position for handling nearly all hip lesions of whatever sort, and I always use it when I can.

This first plaster I leave on six to eight weeks or longer. Not until three months do I dare let the foot to the floor. Repair in these

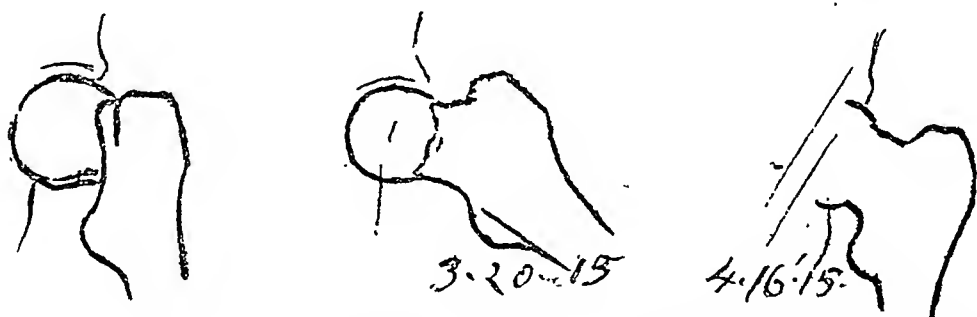


FIG. 11.—Operated for Dr. J. B. Blake; loose fracture; second figure shows after impaction; third figure shows impaction preserved, though with some absorption; early result excellent; too soon for end-result.

cases is slow at best. Always in hip fracture at the neck, there is a considerable absorption. Even with the X-ray, we cannot always judge and it is best to be cautious. From three to six months one is busy with getting the joint mobilized and learning to walk with crutches, bearing little weight on the hurt leg. During this time, nearly all the motion should be regained. After six months the question is one of use, of regaining strength and losing the limp.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting, held December 6, 1915

The President, DR. JOHN H. GIBBON, in the Chair

OSTEOCHONDRITIS DEFORMANS JUVENILIS, OR PERTHES'S DISEASE

DR. JAMES K. YOUNG presented two cases of this disease, one of these, aged five years, was suffering from Perthes's disease of one hip, and the second one, aged five years, was suffering from Perthes's disease of both hip-joints.

The first boy came under observation, July, 1913, at the Polyclinic Hospital, complaining of lameness in the left hip. There is no history of injury and his mother knew of no cause for this condition. There is no history of tuberculosis in the family. The X-ray showed a typical atrophy of the epiphysis of the femur, with some roughening of the cavity of the acetabulum. There was no limitation of motion except in abduction; and the disease, after remaining stationary for a time, has gradually recovered, there being an increased deposit of lime salts. He wore an apparatus to relieve weight bearing, and he was given calcium phosphate in large doses.

The second boy came under observation at the Polyclinic Hospital, November 22, 1914, complaining of knock-knee on the right side. He walked with his toes turned in and his mother noticed this condition for nine months, there was at this time no limitation of motion and the X-ray showed Perthes's disease of the left side. Subsequently, the same condition developed on the other side, in five months. He was treated similarly to the first case and he has now good functional use of the thigh.

Perthes's disease is characterized by atrophy of the upper epiphyses of the femur, due to a subchondral area obstruction, which eventually becomes complete; there is no temperature; there is slight limp, prominence of the great trochanter, some atrophy of the muscles and limitation of abduction, with slight pain from time to time. The patient does not respond to the tests for tuberculosis. After remaining active for a year or more there is a tendency to recovery with slight functional changes.

OSTEOCHONDRITIS DEFORMANS JUVENILIS

The X-rays in the second case are characteristic, and show a flattening and broadening of the head, with a moderate degree of coxa vara. The etiology is obscure, but Legg believes in a traumatic etiology, with "blocking of the blood supply to the epiphysis, due to trauma of the epiphysial line."

DR. GWILYM G. DAVIS said that it is easy enough to diagnose in various affections the well-advanced typical cases, but the trouble comes in atypical ones, such as when we see a child running around with perhaps just a slight or no pain and perhaps a rather marked limp who does not progress apparently beyond that stage. It is possible to conceive of there being a number of possible conditions; for instance, the symptoms may be the result of a rhachitic state, such as bone softening. In arthritis deformans we find in some cases very similar conditions. It is perfectly well known also that in the adult it is not uncommon to find cases of atrophy, especially of the neck of the femur, from injury. Without doubt, following an injury there sometimes follows disturbance of nutrition in the head and in the neck of the femur, which gives rise to local changes. One might call this an osteitis or osteochondritis, but it is hard to determine the exact pathology of the affection. In some of the reported cases changes have been observed in other joints. That would argue a rhachitic condition or one of more or less general disturbance.

Examination from a pathological stand-point shows the absence of any specific taint, the Wassermann and von Pirquet tests being negative. An X-ray plate may be made and if the disease has progressed far enough certain changes may be evident in the head of the bone. To tell, however, the exact character of these cases is very difficult because of the changes being so slight. That which is to be especially guarded against is that we do not mistake an early case of tuberculosis for this condition and permit too great activity. Many of these cases are found to have been preceded by traumatism. One marked case of his appeared almost like a separation of the epiphyses of the head of the femur. The boy presented an appearance of retarded development, almost infantilism. The question arose whether or not he had a more or less general bone softening, with lack of development, in which the local conditions were caused by an accident. If an accident is the sole cause in such a condition in a healthy individual, spontaneous recovery ought to occur; but, if the accident is only an incident in a constitutional disturbance, the case requires entirely different handling, and the proper management of these cases is by no means established, nor have we decided upon any distinct line of treat-

ment to pursue. It would be wise to protect the joint as much as possible and then endeavor to improve the general condition.

DR. ASTLEY P. C. ASHHURST presented an X-ray picture (Fig. 1) of a patient, now eighteen years of age, showing a flat head of the femur. This young man says that when five years old he had a multiple arthritis, which laid him up for about a year. When he got about he was lame in the right hip, and has been lame ever since, but has never been laid up. There is shortening of 1.5 cm., and the thigh is 5 cm. less in circumference than the left. Flexion of the hip is slightly limited, internal rotation is lost, and there is almost complete loss of abduction. The question is, is every case of flat-headed femur an example of so-called Perthes's disease?

Dr. Davis has reminded us that Perthes was not the first to describe the condition. One of the studies of this affection which caught his own attention first was by Calvé, in the *Revue de Chirurgie* for 1910; he called it a "particular form of pseudocoxalgia." A case of coxa vara at the Episcopal Hospital in 1913 was thought to be an example of this affection (Klauder: *Medical and Surgical Reports of the Episcopal Hospital*, 1914, ii, 269).

It must be remembered that for very many years all forms of hip disease were undifferentiated. Then the tuberculous nature of many of them became recognized, and for a time many surgeons considered all cases of hip disease tuberculous. It is only within a comparatively few years that it has been possible to disprove the tuberculous nature of some cases, and among these non-tuberculous cases of hip disease we must place instances of Calvé's or Perthes's disease; but of their true pathogenesis we are still in doubt.

DR. YOUNG, in closing, said that there has been too much confusion in regard to the nomenclature of diseases of the hip. The term hip disease should be used exclusively for tuberculosis of the hip-joint and then there would be less confusion. The term osteochondritis deformans infantilis is a good one, but the term Perthes's disease has been commonly used by orthopædic surgeons, and as his description was the first systematic and complete one, it is not improper to designate this condition as Perthes's disease.

UNUNITED FRACTURE OF THE LUMBAR VERTEBRÆ.

DR. JAMES K. YOUNG presented a man, aged thirty years, who sustained an injury to his lumbar region by falling from a height and striking his spine upon a track of the railroad, ten years ago, and in



FIG. 1.—Coxa vara (flat head) in a patient aged eighteen years, following arthritis at five years of age.

RECURRENT DISLOCATION OF THE SHOULDER-JOINT

whom a diagnosis had only been reached one year ago. There was great difficulty in getting satisfactory X-rays on account of the large size of the patient. The symptoms during this interval resembled, somewhat, the so-called "railway spine," such as usually accompanies ligamentous injuries. The more recent improvement in the Röntgen technic enabled Dr. Pancoast, of the University of Pennsylvania, to take a picture which shows a fracture on the right side of the transverse processes of the third and fourth lumbar vertebræ, both of which are ununited. It is possible by surgical means to remove both of these, but the condition has so greatly improved, the patient is advised not to submit at the present time to operation.

RECURRENT DISLOCATION OF THE SHOULDER-JOINT

DR. JAMES K. YOUNG presented a man who had been operated upon by a new method for recurrent dislocation of the shoulder-joint. The patient was an athletic mulatto, aged twenty years. The shoulder was injured by an overhand throw while playing base-ball, at a western university, in Kansas. The dislocation was subcoracoid, and recurred frequently during the day, interfering with his occupation, which was that of a dentist's helper. The operation which was performed was suggested by Dr. Oscar H. Allis, and consists in dividing the lower half of the insertion of the tendons of the pectoralis major and the latissimus dorsi, and keeping the shoulder in an elevated position until union has occurred. The incision is made between the deltoid and the pectoralis major in front, the cephalic vein is displaced outward, and the attachment of the pectoralis major tendon is found and divided in its lower half. In thin subjects the tendon of the latissimus dorsi can be hooked up from the same incision, but in muscular subjects a second incision must be made along the posterior border of the axilla, until the tendon of the latissimus dorsi is found and its lower half divided. The shoulder is kept elevated for ten days. The patient has had no recurrence of the dislocation since the operation. He also has full strength in the muscles about the shoulder-joint.

This operation appears to be suitable in forward upward dislocations of the shoulder-joint; division of the lower half only of the tendon changes the direction of the action of these two powerful muscles, but does not apparently weaken the action of the muscles about the joint. It will be noticed that the capsule was not sutured, and that the joint was not opened, which obviates one possible source of infection.

RUPTURE OF THE SIGMOID BY INFLATION THROUGH THE RECTUM

DR. A. D. WHITING reported the following case:

J. W., Pole, male, aged twenty-five, was admitted to the Germantown Hospital, November 11, 1915, at 2.30 P.M. While at work, at 1.20 P.M., in a steel mill, in a stooping position, some of his fellow workmen, in a spirit of fun, placed the nozzle of a compressed air pipe within a few inches of his buttock and directed the compressed air, under eighty pounds pressure, through a three-eighths-inch nozzle toward the anus. The patient staggered and then leaned against a wall, but did not fall. With the assistance of a fellow workman, he walked to the Infirmary of the works, where the attending surgeon found the abdomen markedly distended and very tense. A rectal tube was passed, but no gas escaped through it. A small amount of blood was recovered. He was then sent to the hospital.

When first seen by Dr. Whiting, at about 3.15 P.M., his temperature was 97°, pulse 66, respirations 24. Breathing was difficult. The abdomen was distended and tense, and very tympanitic, with marked rigidity throughout but more pronounced in the upper right quadrant. Owing to the inability of the patient to understand English, a history could not be obtained until an interpreter was summoned. Then the patient denied the inflation of the colon, but stated that he had been seized with sudden upper abdominal pain. A diagnosis of rupture of the stomach or intestine was made and immediate operation advised. Before consent to operation could be obtained, the true history was given by the patient to a priest.

Operation (at 6.15 P.M.).—During the interval of five hours between the accident and operation, the patient became very much worse, the respirations were more difficult and the pulse much weaker and more rapid. Incision was made through the lower right rectus. As the peritoneum was opened, there was a gush of air, with blood and fecal matter, followed by immediate improvement in respiratory and heart action, which, however, did not last long. Inspection revealed an opening in the sigmoid, about 3.5 cm. in length, opposite the attachment of the mesosigmoid. This was closed with through-and-through catgut sutures. Further search showed that there had been a tearing of the serous coat of the sigmoid for about 15 cm. The descending colon and rectum were intact. Owing to the poor condition of the patient, it was deemed inadvisable to do a resection. A rapid closure of the rent in the peritoneum was performed, the abdominal cavity was flushed with hot saline, saline solution was adminis-

LUMBAR HERNIA

tered intravenously, and the wound was closed without drainage. The patient reacted fairly well from the operation, but the improvement was not prolonged; his temperature rose, without remission, to 109°, just before his death, 28 hours after operation.

A post-mortem examination showed complete closure of all the tears of the bowels and the absence of peritonitis. A study of the ruptured bowel shows absence of the usual rugations and irregularities of the mucosa, it being perfectly smooth from the stretching. The mucosa shows two tears, one perforating through the peritoneum, and numerous small ones longitudinal in direction. There are one longitudinal and two transverse tears of the peritoneum. There is evidence of hemorrhage between the bowel coats, and a few areas of punctate hemorrhage.

E. Wyllys Andrews (*Surg., Gyn. and Obs.*, xii, 1911, p. 63) has reported a similar case of his own and the histories of 15 others obtained through correspondence and law reports. In 13 of them the inflation of the bowel was the result of practical jokes; in three no mention is made of this feature of the accident.

In all of Andrews's collected cases, as in the present one, the nozzle of the apparatus was not introduced into the rectum, but simply directed toward the anus, the sides of the funnel formed by the buttocks directing the air into the bowel.

In all of the reported cases the intestinal injury was confined to the colon, and usually to the sigmoid, because, as suggested by Andrews, it "traps the air momentarily by its somewhat bent or kinked junction to the descending colon. It thus sustains the first shock of the pressure and, unable to pass the mass of air onward, it yields to the pressure, dilates, and bursts into the free peritoneal cavity."

The mortality of the condition is 100 per cent. without operation. Immediate coeliotomy with resection or repair of the bowel should reduce the mortality about 75 per cent. In Andrews's collected cases, seven were operated upon with a mortality of 57.2 per cent.

LUMBAR HERNIA

DR. JOHN SPEESE and EDWARD H. GOODMAN read a paper with the above title.

DR. WALTER G. ELMER said that a case similar to this is in the University Hospital now. It is that of a little boy treated for infantile paralysis of the leg. There is paralysis of the muscles in the flank so that when he coughs there is a hernia about the size of his fist which bulges out just below his ribs on the right side. There appears to be no urgent need for treatment of this condition at present.

CONGENITAL ABSENCE OF THE FIBULA¹

DR. ASTLEY P. C. ASHHURST reported the following case:

In May, 1912, Edgar A., a boy of seven years, came to Dr. Harte's service at the Orthopædic Hospital. He walked on his knees (Fig. 2), owing to congenital absence of the right foot and lower leg, and a congenital malformation of the left foot. The right tibia terminated as a conical stump below what should have been the middle of a normal leg. On the outer side of the right leg was a tab of tissue which could be moved voluntarily, independently of the leg. The right knee-joint was normal, but no fibula was present on this side. On the left side the knee also was normal, but there was no fibula, and the outer two toes and corresponding portions of the foot were absent. The foot was in a position of marked equinovalgus.

Operative correction of the deformities of the left foot was advised, with use of an artificial limb on the right. The parents refused operation, and the child was not seen again until the autumn of 1915, when he was ten years of age. In the meantime his father had made for him a crude artificial limb which he wore on the right leg, and with which he was able to walk moderate distances. The left foot, however, was becoming more and more deformed, and the parents were now willing for operation. The equinovalgus was now much more marked than at his first visit in 1912—the heel was very high, the inner border of the foot was convex, and the outer border was raised until the sole lay at an angle of 45 degrees with the ground. Skiagraphs (Figs. 4 and 5) showed no astragalus, a deformed calcaneum (perhaps an amalgamation of astragalus, calcis and cuboid) in marked outward displacement, and two tarsal bones, perhaps the scaphoid and one of the cuneiforms. The three inner metatarsals with their corresponding phalanges were present. The operation planned was an arthrodesis to hold the calcis under the tibia in the midline, and a transplant from the tibia to form an external malleolus.

Operation (by Dr. Ashhurst, September 24, 1915).—Esmarch anæmia. An incision was made down the outer side of the leg, beginning 7 cm. above the ankle-joint, and continued forward parallel to the normal course of the peroneal tendons. A tendon

¹ One of the most complete discussions of the interesting subject of congenital deformities of the limbs is that by G. Potel, running through the *Revue de Chirurgie* for 1914, vol. xlix. According to his classification the present case is one of hemimelia. Very evidently it is not a case of intra-uterine amputation; witness the deformities of the left lower extremity, and the tab of tissue adherent to the right leg, and representing an abortive attempt to produce foot or toes.



FIG. 2.—Edgar A., seven years old (May 23, 1912). Congenital deformities.



FIG. 3.—Edgar A., ten years old (December 18, 1915). Three months after operation for congenital absence of fibula (equinovalgus).



FIG. 4.—Lateral view of congenital deformity of foot, before operation.

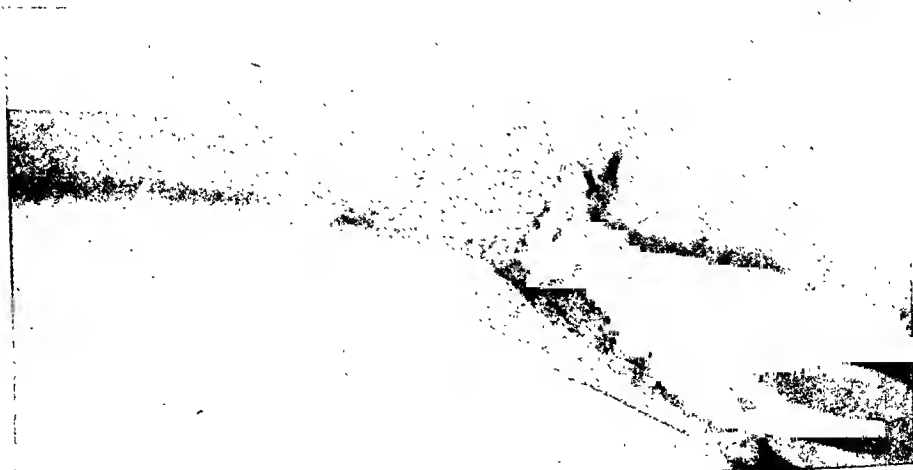


FIG. 5.—Anteroposterior view of congenital absence of fibula and deformity of foot, before operation.

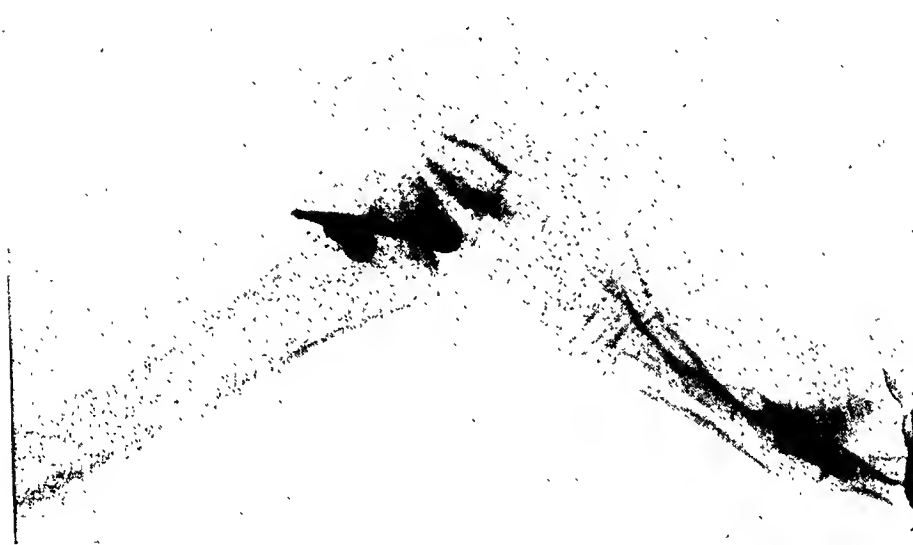


FIG. 6.—Lateral view of foot after operation.



FIG. 7.—Anteroposterior view of foot after operation.

CONGENITAL ABSENCE OF THE FIBULA

was found inserting in the calcis and the base of the outermost metatarsal bone. This tendon was divided by Z-plasty, for subsequent reunion after lengthening. The calcaneum was held by ligaments very tightly against the outer surface of the tibia, and a large upward projecting portion of the os calcis hindered access to the ankle-joint. A second incision was now made along the Achilles tendon, and this tendon was divided by Z-plasty for subsequent reunion with lengthening. This allowed the heel to be brought down, and made the ankle-joint more accessible. The projecting knob was then cut off the upper surface of the os calcis, and preserved to form an external malleolus; it measured about 4 by 2 by 2 cm. Its removal allowed ready access to the under surface of the tibia and upper surface of the calcis as far as the internal malleolus. The calcis was fully 5 cm. broad, and on account of an inward projection from it beneath the internal malleolus it was not possible to bring it plumb under the narrower tibia. A third incision was then made under the internal malleolus, opening the ankle-joint. After removal of the obstructing projection from the os calcis the latter bone could be brought around horizontally under the tibia in excellent position. Many small chips of bone were purposely left at the outer side of the ankle-joint to fill the slight dead space between tibia and calcaneum. Apart from this no further attempt was made to produce an arthrodesis at the ankle-joint. Next the outer surface of the tibia was removed by chisel, bearing cancellous bone, and the raw bony surface of the large mass first cut from the calcis was applied against this tibial surface, forming a very shapely external malleolus. It was fixed to the tibia by two self-boring Lambotte steel screws. This held the foot in admirable position with great stability. The new external malleolus overlapped the calcaneum, and there was not the slightest inclination to a recurrence of the valgus (Figs. 4, 6, and 7). The peroneal tendon and the tendo Achillis were reunited after suitable lengthening, the Esmarch band was removed, and the wounds closed. The foot was kept in plaster-of-Paris for about ten weeks, when a suitable ankle brace was applied. There is sufficient movement in the ankle-joint, the foot stays in perfect position, and with an artificial leg on the right side the boy is well equipped for locomotion. The ankle brace will be worn for about six months, or until the transplant from the calcaneum has become incorporated with the tibia.

DR. GWILYM G. DAVIS said that he had had a couple of cases similar to this one. In one the leg was considerably shorter than the opposite limb. In this case he bent the foot around until it came straight with the leg and resected at the ankle, putting the end up on the cut tibia

so that it increased the length of the tibia and made a straight leg. By making an artificial foot the deformity was very much corrected. The other case was that of a young child and in it the tendency of the foot was to swing outward. In such a case when the child is very young, the best management is to correct the valgus by bringing the foot straight, holding it straight with braces with the foot persistently under the leg, so that the leg may accommodate itself to the foot at the ankle-joint. When the child has grown to approximately nine years of age some such operation as Dr. Ashhurst has done can be performed. Of course, the ease of the operation and its efficiency depend upon the amount of growth of bone at the time it is done. The foot can thus be held in its proper relation to the leg without the fibula, and all necessity of apparatus is dispensed with.

ENDOTHELIOMA OF LEFT FRONTAL LOBE

DR. CHARLES F. NASSAU and DR. GEORGE E. PRICE presented the following case:

Man aged thirty years, a native of Pennsylvania, white and a carpenter by occupation, who was admitted to the service of Dr. Nassau, at the Jefferson Hospital, February 12, 1915.

The family history was negative with the exception of the father's death from cancer of the thigh during the previous summer.

The patient himself gave a history of having had diphtheria, pneumonia and measles in childhood. He denied venereal infection, stated that he used but little alcohol and smoked in moderation. He had been married seven years and had two healthy children. His wife had one miscarriage. With the exception of a trivial accident affecting the left knee, there was no history of the patient having received any injury.

Twelve years ago, he had consulted an oculist because of headache, but after wearing glasses for six months the headache disappeared and he remained free from the trouble for ten years. Two years ago the headache returned, this time being unrelieved by correction of refraction.

In May of last year, he had an epileptiform attack, in which he was found unconscious and with his head turned strongly to the right. A second similar attack occurred one week later, but since this spell he has had no recurrence.

Following these attacks, the headache steadily increased in severity and would often last for days without intermission. The eye-grounds at this time were reported as being negative. Next, his eyesight failed rapidly, and, on December 11, 1914, the local

ENDOTHELIOMA OF LEFT FRONTAL LOBE

surgeon removed a button of bone from the right temporal region without opening the dura. This operation, despite the failure to open the dura, was followed by rapid improvement of vision until about two weeks prior to his admission to the Jefferson Hospital, when it remained stationary. The headache had continued, but with lessened severity. There was no nausea nor vomiting at any time.

Upon examination, some tenderness was noted in the muscles of the left side of the neck near the occiput. There was no bulging at the site of the operation in the right temporal region. The lungs and heart were normal. Over the ninth and tenth dorsal vertebræ was observed a small tumor, not freely movable, but over which the skin could be readily moved.

Urine and blood examinations revealed nothing abnormal and a Wassermann test of the blood serum was reported negative.

An ophthalmological report, made by Dr. Sweet on February 13, 1915, was as follows: Pupils 3.5 mm.; reaction normal to light and convergence. Media clear, tension normal, ocular rotation unimpaired. Both optic nerves covered with exudation, extending several mm. beyond the normal edges; veins tortuous; retinal striations, particularly in R. E. No hemorrhages; swelling R. nerve about 5 D., swelling L. nerve 6 D. from a base of 2 D. Diagnosis: "Choke disk." Visual field shows slight concentric contractions of the right, but none in the left eye. There is enlargement of the blind spot in each eye.

Neurological Examination.—Gait and station normal. The pupils were slightly unequal, the right being the larger; both reacted to light and accommodation. There was no nystagmus, external ophthalmoplegia nor hemianopsia. No gross impairment of hearing. Musculature and sensation of face normal. No difficulty in articulation nor in swallowing. There was no aphasia. Grip with both hands fair and equal: no dysmetria; no diadococinesis. The knee-jerks were normal. Upon testing for Babinski's sign, it was observed that the right great toe would sometimes flex, but at other times it would extend. Stroking under the outer malleolus on this side would usually cause extension. On the left side, there was always the normal reflex—flexion. Sensation was everywhere normal. Astereognosis was not present. No mental symptoms were observed and the man's conduct in the ward was said to be that of the ordinary patient.

While the absence of definite symptoms prevented a positive localization, it was felt that this same paucity of localizing symptoms favored a growth in the frontal region, while the turning of the head to the right side in the epileptiform attack and the occasional Babinski on the right side pointed toward a left-sided

lesion. In accord with this conclusion was the fact that the swelling of the optic disk was most marked on the left side and it was further noted that most of the headache was on the left side, beginning in the temporal region. Accordingly, at operation Dr. Nassau began by turning down a flap on the right side, where the button of bone had been removed in Erie, thinking for safety's sake a decompression could be done on the right side. When the decompression opening was made on the left side, just appearing at the edge of the hole was seen a little bluish-gray appearance of the dura, which was extremely thick. A large portion of the lower inferior angle of the parietal bone was removed with the Rongeur forceps. Bleeding was very profuse, and was controlled with hot packs and Horsley's wax. After incising the dura, a large mass bulged up into the wound anterior to the fissure of Rolando. After starting the separation with the finger, the mass peeled out very well. It left an enormous cavity. Just here he emphasized the wisdom of performing such an operation in two stages when a severe hemorrhage is encountered. If he had finished this operation in one stage, he would have lost his patient. Iodoform gauze was gently packed into the cavity and the scalp brought over the gauze with just one silkworm-gut suture. An enormous Turk's head dressing was applied, using a Halsted gauze roll. Patient was sent to the ward in deep shock. The operation was done February 17, 1915. Five days later, without anæsthesia, he removed the packing from what was then not much of a hole. The wound was closed, with the exception of two small drains. By merely laying gauze in a brain cavity, one does not make injurious pressure, and unless the bleeding is from a large vessel, it will always stop. Of course there should be no visible bleeding point. In mere oozing, one gains nothing by a hard pack on the brain. When the pack was removed, some active bleeding occurred from a vein that was easily tied. March 7, 1915, eye report at this time choked disk, right eye, 1 D, and the left eye $2\frac{1}{2}$ D. He was now turned over to the Radium Department, and he was treated by Dr. Newcomet for about 8 weeks. There is now absolutely no appearance of any growth whatever. He seems to be perfectly well.

The tumor was examined by Dr. E. D. Funk, who made the following report:

Specimen is an irregular, ovoidal mass of soft, grayish-red tissue, measuring 8 by 5 by 3 cm.; weight 93 gms. One surface is convex and shows slight fissure-like markings. This surface is covered by a thin, smooth, moist membrane. The remaining surface is a torn, rough, dark-red area measuring 1 cm. square, to which a small portion of dura is

ENDOTHELIOMA OF LEFT FRONTAL LOBE

attached. The mass cuts easily and the incised surfaces exhibit a grayish color.

Accompanying the larger mass is a small grayish-white piece of dura measuring 1 cm. square and 0.2 cm. thick.

Specimen was fixed in absolute alcohol, embedded in paraffin, sectioned, and sections stained with hæmatoxylin, eosin and Van Gieson's mixture.

Histology.—The sections show many islands of closely arranged cells containing prominent nuclei. These lie in irregular spaces formed by the fibrous connective-tissue stroma.

Diagnosis.—Endothelioma.

Dr. Nassau remarked further that tumors of the posterior part of the frontal lobe usually give rise to Jacksonian convulsions by involving the motor area, and on the left side, if the foot of the third frontal convolution, or Broca's area, be invaded, motor aphasia develops.

In the prefrontal region, however, diagnosis is rarely made from any direct focal symptoms. According to Starr, "A decided change in character and disposition, a mental apathy and a tendency to somnolence must be regarded as a sign of frontal lobe disease." Oppenheim states that such psychic disorders as simple dementia and a peculiar face-tiousness, to which he applied the term *witelsucht*, are of frequent occurrence in tumors of the frontal region. Unfortunately, mental symptoms may result from tumors located in other portions of the cerebrum, and, when present in frontal growths, they do not indicate the particular hemisphere in which the neoplasm may be found.

Bruns and Dercum have observed a cerebellar-like ataxia in cases of frontal lesion and Stewart has noted tremor of the extremities on the homolateral side, also loss of the superficial abdominal reflex. None of these findings are constant, however.

In this case, none of the symptoms described above were present. A symptom which had some localizing value was the occurrence of convulsions with turning of the head to the right side. It is well known that irritation of one part of the cerebral cortex may spread or radiate to adjacent parts, which Starr likens to the ripple on the surface of a lake into which a stone has been thrown.

The absence of mental symptoms in this patient may have been due to the character of the growth, as the endothelioma does not actually infiltrate and destroy the brain substance, but growing from the dura it pushes aside the cortex and embeds itself, or makes a nest for itself, in the brain. Moreover, the rate of growth of this variety of tumor is slow and would, therefore, permit of considerable adaptation on the part of the brain to the changed condition.

Probably no tumor of the brain offers a more favorable outcome to the surgeon than does the endothelioma. Well defined from the surrounding tissue, it is, as a rule, readily removed, and when completely removed the liability to recur is slight. The operator must see to it, however, that the growth is not broken, or if this occurs, great care should be taken to remove all of the tumor, as, should a piece of the growth be left, recurrence is probable.

PRE-OPERATIVE TREATMENT OF HANDS AND FIELD
OF OPERATION

DRS. A. D. WHITING and MORRIS A. SLOCUM read a paper with the above title.

To Contributors and Subscribers:

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N. Y.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS *of* SURGERY

**227-231 S. 6th Street
Philadelphia, Penna**

ANNALS *of* SURGERY

Vol. LXIII

APRIL, 1916

No. 4

ACIDOSIS IN SURGERY

A REVIEW OF 138 CONSECUTIVE MAJOR OPERATIVE CASES, IN WHICH THE DOMINATING INFLUENCE OF ACIDOSIS WAS CONSIDERED

BY GARNETT W. QUILLIAN, M.D.

OF ATLANTA, GA

VISITING GYNÆCOLOGIST TO THE GRADY (CITY) HOSPITAL

MORE than a year ago (October, 1914) in preparing a diabetic patient with gangrene of the foot for high amputation, the dominating influence of acidosis was appreciated, though not understanding perfectly its phenomena. At this time it was demonstrated that when diacetic acid was present in the urine of the patient, the gangrene of the foot became more progressive, but when, by absolute rest, and the liberal use of soda bicarbonate and dextrose, the urine became free of diacetic acid, the patient's condition, both local and general, considerably improved. The limb was amputated at the junction of lower and middle thirds of the femur and the patient recovered from the operation, the incision healing with comparatively little delay. A routine preliminary examination for diacetic acid has since been made in every operative case, and since June 1, 1915, whether an acidosis was present or not, soda bicarbonate and dextrose have been given to every patient as a routine preliminary preparation for operation, the same being used liberally in post-operative care as well.

The article of Crile, "Influence of Acidosis in Surgery" (ANNALS OF SURGERY, September, 1915), prompts me to report 138 consecutive major operative cases in which the acidosis factor was considered. In his paper Crile points out that operative trauma and inhalation anæsthesia always produce acid by-products, which affect primarily the brain, the adrenals, and the liver, and thereby encourage the production of an acidosis with its resulting shock. The fact that in this series of cases there was no mortality, and in only five appreciable shock, leads me to the belief that the preliminary treatment and post-operative care played no unimportant part. A large percentage of these operations was performed on women during a recent service at Grady Hospital and since June 1, 1915. These include:

| | |
|--|----|
| Appendectomies (acute appendicitis) | 27 |
| Appendectomies (chronic appendicitis, and incidental routine while the abdomen was open) | 73 |

| | |
|--|----|
| Complete hysterectomies (carcinoma cervix) | 3 |
| Subtotal hysterectomies (fibroid uterus) | 9 |
| Nephropexy | 4 |
| Repair uterus (rupture) | 1 |
| Cæsarean section (abdominal) | 5 |
| Herniotomy (umbilical, 3; inguinal, 1) | 4 |
| Resection omentum (post-operative adhesions, 4; obstruction of small intestine, 2) | 6 |
| Resection ovary (cystic degeneration) | 45 |
| Round ligament suspension (Gilliam) | 24 |
| Round ligament suspension (Murphy) | 14 |
| Salpingo-oöphorectomies (salpingitis) | 29 |
| Resection ileum (sarcoma) | 1 |
| Exploration (inoperable carcinoma small intestine) | 2 |
| Myomectomies (intramural fibroid) | 4 |
| Cholecystostomy (cholecystitis) | 2 |
| Percy cautery (inoperable carcinoma cervix) | 2 |
| Abdominal cavity filled with normal saline solution (tubercular peritonitis)... | 2 |

In one of the Percy cautery operations, the second part was performed by Dr. L. S. Hardin. In no case was an ovary or tube sacrificed when it was at all possible to retain it. In none of the above cases was Crile's anoci-association practice employed, but in every case acidosis was avoided and the operation was performed as rapidly as was consistent with careful technic, and with the least possible shock from hemorrhage and manipulation. In fifteen of this series the transverse abdominal incision was employed with most gratifying results.

The following preliminary and post-operative routine was followed in every case except a few emergency cases when glucose and soda bicarbonate aa $\tilde{5}$ ss was given in a retention enema a short time preceding operation:

Preliminary.—Soda bicarbonate $\tilde{5}$ ss in $\frac{1}{2}$ glass water t. i. d. $\frac{1}{2}$ hour before meals, for two days preceding operation.

Soda bicarbonate and glucose aa $\tilde{5}$ ss with water q. s. ad $\tilde{5}$ viii as a retention enema, b. i. d. for two days preceding operation.

Liquid diet, and large quantities of water for 48 hours preceding operation, but no buttermilk nor egg albumens for 24 hours preceding operation. (This to prevent accumulation of gas.)

Castor oil $\tilde{5}$ ss the morning preceding the day of operation.

S. S. enemas the night before and morning of operation.

Bichloride of mercury douches 1-10,000, if vaginal work is to be done, the night before and morning of operation.

Strontium bromide Gr. xxx the night preceding operation (to insure a good night's rest).

Morphia Gr. $\frac{1}{8}$ with scopolamine Gr. $\frac{1}{100}$ one hour preceding gas and ether anæsthetic.

Post-Operative.—Adrenalin chl. m xv. q. 6. h. for three doses.

Pituitrin $\frac{1}{3}$ to $\frac{1}{2}$ c.c. six hours after operation, to be repeated in one hour. (This anticipates and combats secondary shock and acting also as a diuretic, in

ACIDOSIS IN SURGERY

many cases makes catheterization unnecessary, thereby avoiding possible unpleasant cystitis.)

Saline and black coffee aa \bar{s} iv to be retained if operation is prolonged or necessary to combat shock. (May be given q. 6. h. for several days.)

Codeine sulphate Gr. i p. r. n. for pain. (Morphine is rarely used.)

Strontium bromide Gr. xx p. r. n. for sleep.

Soda bicarbonate \bar{s} ss in $\frac{1}{2}$ glass of water $\frac{1}{2}$ hour a. c. for several days after operation.

Water and liquid diet when nausea ceases for three days. After which a light diet is allowed.

An eliminant is given on the third day following operation.

Of the tabulated series, there are several cases of especial individual interest:

CASE 61.—This patient entered the hospital on July 15, 1915, with a hæmoglobin of only 18 per cent. Various tonics failed to raise the percentage, so on August 21 transfusion was done, her husband being the donor. The hæmoglobin was raised to 50 per cent. immediately, and on September 2 the percentage had increased to 55. On this date operation was performed, and on September 27 patient was dismissed from the hospital with a hæmoglobin of 70 per cent., having had an uneventful recovery.

CASE 58.—Though comparatively a simple operation, this patient left the operating table in apparently perfect condition, but four hours later suddenly and unexpectedly suffered an almost complete collapse—unconscious, pulse imperceptible, respiration very difficult. The foot of the bed was elevated, and pituitrin i c.c. was given. In about one-half hour the patient recovered consciousness, and seemed to be in good condition again. She remained normal for three hours, when suddenly and without warning she suffered a second collapse, not quite so severe, however, as the first. The same treatment was given with oxygen added, and after a short time she again became normal. In six hours, the patient again suffered a similar collapse, but not quite so severe as the one preceding, again recovered, and during the succeeding 72 hours suffered at varying intervals six distinct similar attacks, each one being slightly less severe than the one preceding. The same emergency treatment was given, the patient having a long eventful convalescence, developing middle ear and other complications. The diagnosis which was suggested, and which was concurred in by several of the most prominent surgeons in Atlanta, was that of embolism.

CASES 22, 31 and 63.—In each of these cases there were extensive adhesions of the intestines and multiple raw surfaces with profuse hemorrhage difficult to control. The dry coagulin powder was sprinkled over the bleeding points in two cases, and the solution given intravenously in the third seemed to arrest the trouble—

some hemorrhage immediately, so that packing with gauze was unnecessary.

CASE 99.—This patient in addition to being sixty-four years of age, and having intestinal obstruction from omental adhesions from an old umbilical hernia, had diabetes. Diacetic acid was kept eliminated from the urine, and while a small opening in the transverse incision drained for several weeks, she had an uneventful recovery.

CASE 89.—This patient had a ruptured, gangrenous appendix, and on the seventh day developed a fecal fistula. This, however, in two weeks closed spontaneously, and after the second operation, closing the wound, recovery was uneventful.

CASE 52.—This patient, in addition to a twelve-pound fibroid tumor of the uterus, had an umbilical hernia. A T-incision was made extending transversely six inches, and perpendicularly from the symphysis pubis to the umbilicus; delivery was easy, closure simple, and recovery prompt.

CASE 88.—This patient punctured her own uterus with a wire which was run through a catheter, and which had been "loaned" to her by a "friend" with which to produce an abortion. While straining at stool, she forced a loop of small intestine into the uterine canal through the tear. At the time of operation some six hours later she was in extreme shock. The intestine was replaced, the wound in the uterus closed, the abdomen drained, and the incomplete abortion completed. With the exception of a mild peritonitis, recovery was prompt.

CASE 57.—This patient was a negro child fourteen years of age with a contracted pelvis (full term), who was admitted to hospital with paresis of the tongue and left lower limb. Section was successfully performed, and the normal use of tongue and limbs returned six hours after reacting from the anæsthetic.

CASE 137.—In this case twins were delivered.

Very few of the 138 cases suffered nausea of any consequence; in only five was there sufficient post-operative shock to cause anxiety, four due to prolonged operation, who responded to stimulation, and one due to flatulency, who responded to peristaltin.

The conclusions which are naturally deducted from a careful observation of this series of cases are:

(a) Acidosis has a dominating influence in surgery.

(b) By preliminary and post-operative treatment acidosis may be largely eliminated, which is just as important as the operation.

(c) Post-operative discomfort and nausea is greatly diminished by liberal preliminary use of soda bicarbonate.

(d) Surgical shock may be avoided by preventing acidosis and by rapid, careful technic in operative procedure.

PULSATING EXOPHTHALMOS*

WITH REPORT OF A CASE CURED BY LIGATION OF COMMON CAROTID ARTERY

BY GOODRICH B. RHODES, M.D.

OF CINCINNATI, OHIO

THE subject of pulsating exophthalmos has been studied by many writers, notably Sattler, Eysen, and de Schweinitz and Holloway, whose monographs cover the reported cases to 1908. Sattler has collected 106 cases, Eysen 167, and de Schweinitz and Holloway 69, a total of 342. A study of these cases, however, reveals the fact that a number of cases are duplicated in Eysen's and de Schweinitz and Holloway's lists, reducing the actual number to 256. Since de Schweinitz and Holloway's study there have appeared in the literature 52 cases of pulsating exophthalmos. These I have collected and made, together with my own case, the basis of this study.

The symptom-complex of pulsating exophthalmos has been shown by operation and autopsy to be caused by one or more of the following lesions: aneurism of the ophthalmic artery inside or outside of the skull, pulsating orbital tumors, aneurismal dilatation of the internal carotid artery in the cavernous sinus, thrombosis of the cavernous sinus and ophthalmic vein, arteriovenous aneurism of the orbit, pressure on the sinus by an external growth, and rupture of the internal carotid into the cavernous sinus. This paper will concern itself solely with those cases probably due to rupture of the internal carotid into the cavernous sinus, whether caused by trauma or occurring spontaneously. I say probably, for the diagnosis is not always certain, as Wilder found no lesion of the carotid in six clinically characteristic cases which came to autopsy. There were no postmortems made in my series.

In this series of 53 cases 37 were found to be traumatic in origin, 9 occurred spontaneously, while in 7 the cause was not given.

The average age of the patients was thirty-six. The youngest was fifteen, and the oldest, a spontaneous case, was eighty-four.

There were 31 males and 10 females, the sex not being mentioned in the other 12 cases.

In the traumatic cases the time elapsing from the receipt of injury to the appearance of the first symptom, bruit, clings remarkably closely

* Read before the Southern Surgical and Gynecological Association, December 13, 1915.

to an average of 21 days. To this fairly constant latent period certain cases present a marked exception, six cases occurring immediately upon receipt of the injury, while the cases of Lystad, Orloff and Hildebrand show intervals of two years, six months, and four months respectively.

The left eye was affected in 15 cases, and the right in 23. A bilateral involvement occurred in 4 cases, 2 of them being spontaneous in origin, 1 due to trauma and the fourth having no cause mentioned.

Upon the classic tripod of exophthalmos, orbital pulsation and a bruit audible both to patient and examiner, is built up a superstructure of phenomena which can be divided into those due to the aneurism itself, and those caused by nerve lesions either traumatic in origin or resulting from prolonged circulatory disturbances set in motion by the reversal of circulation. The exophthalmos, bruit and pulsation are obviously due to the aneurism and are among the first to appear, and of these the first and most constant in its appearance is the bruit. Exophthalmos occurred at later periods, varying from a few days to a month after the bruit. Pulsation is a still later symptom, appearing within a few days after exophthalmos has been noticed. The subjective character of the bruit is variously described by the patients. We read of noises like escaping steam, rattle of machinery, chirping of birds, and other comparisons expressing sounds entirely unlike. Objectively the bruit is the typical arteriovenous aneurismal bruit, with systolic accentuation, usually heard with greatest intensity over the orbital cavity or the temporal area, and along the course of the vessels in the neck. In some cases it was of interest to note that the only place where the bruit could be heard was along the lateral sinus.

Certain nerve lesions are commonly noticed which can be explained by a study of the anatomy of the region. The most serious lesion is atrophy of the optic nerve, either due to immediate laceration from basal fracture, pressure or slow development from continued circulatory disturbance. . Paralysis of the motor mechanism of the eyeball is in some cases due to extreme exophthalmos, in which cases the globe is immovable, and in others due to lacerations or pressure upon individual nerves, among which the abducens is most common. This nerve was paralyzed in 9 cases, among which one was spontaneous, namely that of Hird and Haslam. It has been claimed by some authors that paralysis of the abducens is characteristic of the traumatic variety exclusively, and is indicative of basal fracture, but this individual presented a slowly developing external rectus paralysis beginning six days after admission to the hospital with spontaneous pulsating exophthalmos.

Loss of pupillary reflex with persistent dilatation of the pupil

PULSATING EXOPHTHALMOS

occurs in many of the cases, both spontaneous and traumatic, and is due to laceration of the carotid plexus of the sympathetic. Injury to the superior petrosal nerve carrying facial nerve fibres is said by some to be responsible for the absence of tear secretion, but was observed only in the case of Lystad.

Various minor symptoms are encountered with great frequency. Among these are diplopia, hemorrhages or œdema of the retina, tortuosity and dilatation of the retinal veins. Almost all cases show an increase in ocular tension, but only two cases developed an absolute glaucoma.

Facial paralysis is a rare symptom, occurring most often in the traumatic type of the disease, but like abducens paralysis can no longer be said to be confined purely to that variety.

Any study of the forms and effects of treatment must necessarily be complicated by many factors. It is not to be expected that gross nerve injuries occurring primarily will be cured by any method at our command, nor will cases coming late to operation with complete degeneration of the optic nerves be restored to vision by a cure of the aneurism. By a cure we understand, then, those cases in which the exophthalmos, pulsation, bruit, and chemosis have been permanently stopped. In addition we find that several methods of treatment have been frequently employed in the same case. These have been classified as a failure for the first form of treatment employed, but if a cure resulted after other methods were used in addition, it was recorded as a cure of the combined treatment. A carotid ligation in itself may be a failure, but may produce enough change to enable a subsequent ligation of the ophthalmic vein to perfect the cure.

The methods of treatment employed in these 53 cases embrace practically all the known procedures which have been advanced, with the exception of electropuncture:

1. Ligation of common carotid alone. Fifteen cures, 3 improved, and 4 failures. One of these failures, reported by Buchtel, resulted in death, from what cause is not mentioned. Another one, that of Barbieri, died from secondary hemorrhage. Thus we have a mortality of 9.1 per cent. for this method. Previous estimates of the mortality are given by Eysen, 6.2 per cent., Orlow, 8.3 per cent. and de Schweinitz and Holloway, 11.7 per cent. Averaging these percentages we have a general mortality of all reported cases of 7.8 per cent. for carotid ligation. It must be remembered, however, that a considerable number of these patients died from secondary hemorrhage, as a result of operation in the pre-aseptic period, so we are faced by the fact that our

mortality at the present day is greater by far than the mortality from the first 113 cases reported, in which there was only 1.9 per cent. The mortality from carotid ligation should be merely the mortality of the disease for which the ligation is done, therefore a percentage of 7.8 per cent. would seem to be entirely too high. The mortality of carotid ligation for all causes, in 172 cases as compiled by Siegrist from 1881 to 1897, is 20.5 per cent.

In a certain number of instances the bruit and pulsation are stopped when the common carotid of the same side is compressed. Others are unaffected. Common carotid ligation effected a cure in 10 cases in which digital compression over the carotid absolutely stopped the bruit and pulsation. In 1 such case carotid ligation failed to cure. On the other hand, in 3 cases in which pressure failed to check pulsation and bruit, failure resulted from carotid ligation alone. May it not be possible to derive from this a prognosis of the probable result of operation by ligation of the carotid? To make a more complete study of this point I have reviewed the 106 cases of Sattler, and I find 33 of these in which observation of the effect of pressure on the bruit is made. The results are as follows:

| | |
|---|----|
| Cures when digital pressure completely stopped the bruit..... | 19 |
| Failures when digital pressure did not completely stop the bruit..... | 6 |
| No cure when digital pressure completely stopped bruit..... | 4 |
| Cures when digital pressure failed to completely stop the bruit..... | 4 |

By combining these figures deduced from Sattler's statistics with mine it will be noticed that 38 out of 47 cases, or roughly 80 per cent., will support a prognosis which may be expressed as follows: Pulsating exophthalmos in which digital pressure on the common carotid of the same side stops the bruit completely will probably be cured by ligation of that common carotid alone. Or, this might better be expressed, that pulsating exophthalmos in which digital pressure on the common carotid fails completely to stop the bruit will probably not be cured by simple ligation of the common carotid. Emphasis is laid on the bruit because it is the most persistent symptom and yet the one which is detected with the greatest delicacy by the patient.

2. In 1897 Schimanowsky first ligated the superior ophthalmic vein, after unsuccessful ligation of the common carotid. This orbital operation, commonly known as Sattler's operation, was performed as a primary procedure in 3 cases in this series with 2 successes and 1 failure. One of the successful cases was operated on by the temporary resection of the outer wall of the orbit.

PULSATING EXOPHTHALMOS

3. Continuous compression of the common carotid was resorted to in 8 cases. Only 1 of these, that of Claiborne, was cured, after wearing a constant pressure bandage for eighteen months.

4. Injections of gelatinized serum after the method of Lancereaux and Paulesco were carried out in 6 cases. Two were cured, 2 improved, and 2 received no benefit. The treatment consists in the intramuscular injection of 2 per cent. solution of gelatin in serum. Five per cent. or more is very painful and causes a rise of temperature. Less than 2 per cent. is without effect.

5. In one case Cunningham produced a cure by the use of Neff's gradually contracting clamp (catgut and rubber band) applied to the common carotid.

6. Ligation of internal carotid. This method is the operation most highly recommended by various writers. Of the 4 cases so treated 1 was cured and 3 were improved. No failures resulted.

7. Ligation common carotid combined with ligation of superior ophthalmic vein, angular vein, inferior ophthalmic vein or any other orbital vein which is found dilated or pulsating. Three cases were cured and one failed by this method.

8. Weinkauff reports one spontaneous cure in an eighty-four-year-old woman, apparently a case produced spontaneously.

9. Ligation of common carotid and superior thyroid. Two cases were cured. No failures.

10. One ligation of the external carotid was employed with a successful result.

11. Ligation of the common carotid followed by ligation of the internal carotid resulted in improvement in one case.

12. Ligation of both the external and internal carotid together with the internal jugular vein in one case resulted in failure. This same case subsequently treated by the orbital operation was greatly improved.

13. Zeller has proposed the following operation: Ligation of the internal carotid close to the skull in the neck combined with ligation of the artery just proximal to the origin of the ophthalmic artery. Cadaver experiments showed him that it is possible only in exceptional cases to see the origin of the ophthalmic artery and to put a ligature proximal to it around the internal carotid without pulling on the latter vessel. In the single case in which this method was tried the ligature sawed through the artery before it was tied. The patient died of hemorrhage.

14. Enucleation of the orbit was resorted to in 2 cases in which absolute glaucoma developed.

The total number of cures by all methods is 26. Nine were improved and 10 resulted in complete failure.

It is hard to draw any accurate conclusions as to the best method of treatment from so small a collection of cases, but the total number of reported cases is so small that we must be guided more by a study of the individual ones than by statistical deductions in arriving at any conclusion. Ligation of the common carotid is undoubtedly the classical operation, first performed by Travers in 1803, and is probably the safest method. But even in this procedure deaths have occurred, and in this series cerebral complications occurred in two cases, paralysis of forearm and hand and difficulty of speech in the one instance, and in the other aphasia and facial paralysis occurred one month after ligation, so it is only fair to assume that it was due to extension of the clot into some small branches of the middle cerebral. The orbital operation, while yielding good results, exposes the patient to great danger from hemorrhage in some cases. No method has proved free from danger. Even the gelatinized serum injections of Lancereaux-Paulesco have resulted in apoplectic attacks probably due to embolism or thrombosis.

In the case of immediate failure by any one method, what shall be done? Cures have resulted from various ligations after long periods, but shall we await that result, or shall a second operation be made within a few days or weeks? This would seem to depend entirely upon the condition found by the oculist, who should work in conjunction with the surgeon. If the optic nerve is completely atrophied it might be well to await the result of the first ligation, but if the nerve is not entirely gone the case should be kept under constant supervision by an oculist, and a second operation performed when in his opinion permanent damage to the nerve is seen to be threatening. The second operation which gives the best results would appear to be the orbital ligation. Ligation of the other common carotid was only practised in one case, resulting in failure, and would not seem to possess any more advantages, and to present greater dangers than the orbital operation.

AUTHOR'S CASE.—W. W., male, aged twenty-seven, was struck October 29, 1914, on right side of head by a thug. He was knocked over to the left side and struck the left side of his head against a pile of granite blocks. No visible wound. Unconscious for a short period, but was able to walk to his home, suffering intense pain and vomiting frequently. Within 24 hours he noticed a throbbing noise in his head. This, with headache, steadily increased and

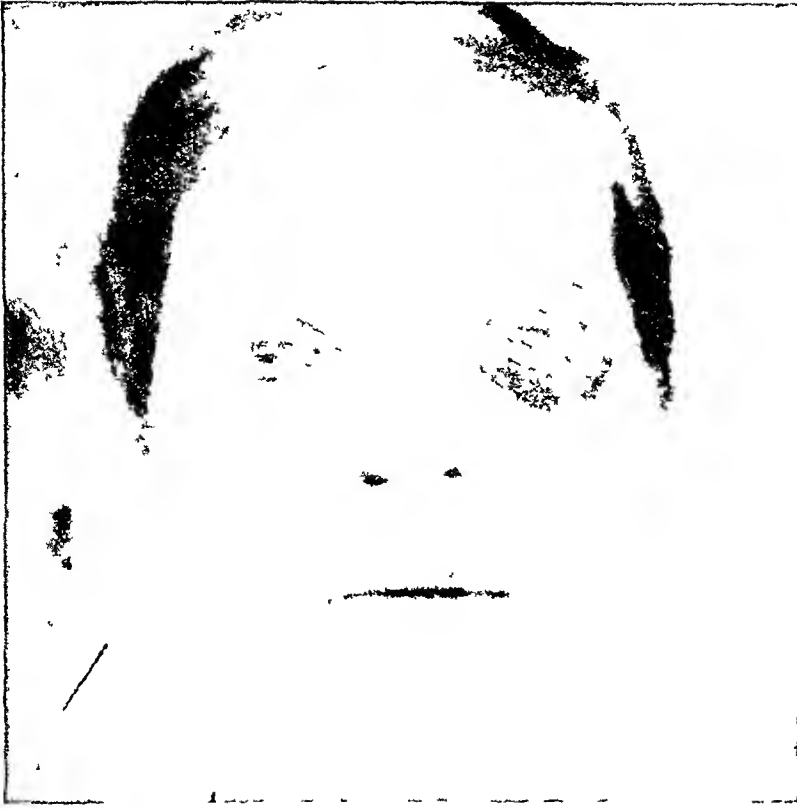


FIG. 1.—Condition in December, 1914, before ligation of left common carotid artery,



FIG. 2.—Condition five months after ligation of left common carotid artery: aneurism cured; no exophthalmos or pulsation. Clot in orbital veins of right eye developed April 10, 1915.

PULSATING EXOPHTHALMOS

persisted, followed by prominence of the left eye with intense venous congestion of the conjunctiva of both eyes. Vision of left eye blurred. December applied for treatment to Dr. Robert Sattler, to whom I am indebted for the privilege of operating upon this case. Exophthalmos of fully 2 cm. of left eye (Fig. 1). Orbital pulsation. Bruit heard most distinctly over the eye and adjacent temporal region. Patient complains of constant rhythmic loud noise in the head which allows him little sleep. Pronounced chemosis present.

Ophthalmic examination by Dr. Sattler showed marked venous stasis with enormous dilatation and tortuosity of the branches of the central retinal vein and general œdema of the retina. Orbital venous stasis of right eye. Compression of the left common carotid silences both the subjective and objective bruit and reduces the orbital tension. Exophthalmos is lessened, but does not entirely disappear. Pulsation ceases immediately.

Operation (January 22, 1915).—Ligation of common carotid with two silk ligatures. No symptoms were noticed when ligature was tied. The patient had immediate and permanent relief from the bruit and pulsation, while the exophthalmos receded very gradually, being still noticeable four months later. Vision returned to normal and remained so. April 10, 1915, three months after operation, he developed an intense chemosis of the lids of the right eye, but no exophthalmos nor pulsation (Fig. 2). This subsided after several weeks, aided by a plastic operation performed by Dr. Sattler, and was thought to be due to the extension of the clot into the orbital veins. He is now perfectly cured.

CASES FROM THE LITERATURE

I. CUNNINGHAM: White man, aged thirty-nine, no previous disease except dysentery (Philippines). Four years ago in a fight was struck on left cheek. Spat blood and felt sick. Two days later roaring in head began and gradually grew worse. Could not sleep lying down and spent nights in chair. Two months later sudden pain in right temple, and eye protruded to a marked degree. Diplopia and dilatation of superficial veins over eye and temple. While returning from work he became temporarily unconscious. Taken to hospital.

Decided to try Neff's clamp (*Jour. Amer. Med. Assoc.*, August 26, 1911, p. 700), catgut, and rubber band. Applied so that faint pulsation was noticed distal to clamp. Visible pulsation disappeared in orbit. Bruit lessened. Four days later both had entirely disappeared. Left hospital on tenth day.

September 30: Exophthalmos lessened. No bruit or pulsation, or roaring in head.

October 9: Clamp removed. Found to have cut its way through artery. Dysphagia by pressure on trachea. Improved spring pressure clamp described, to lie parallel to vessel, and not press on surrounding tissues.

II. BEAUVOIS, A.: (1) Woman, aged forty-one, fracture of base of skull from falling down stairs. Month later, right exophthalmos; no pain. Systolic

murmur. Later, right-sided abducens paralysis, diminished vision. Ocular and carotid compression without result. Common carotid ligated three months after accident. Murmur ceased, slight aphasia and left lid paresis. Exophthalmos persisted, but less. Gradual loss of vision. Ten days later murmur reappeared but could be stopped by compression of left carotid. Injected 5 c.c. of 1 per cent. gelatinized serum into thigh every other day. After three injections (Lancereaux-Paulesco), injection increased to 20 c.c., then 50 c.c., at last to 100 c.c. Exophthalmos disappeared, but paralysis of both abducens and slight dilatation of pupil persisted. Three months after beginning treatment a local cure.

III. (2) Woman, aged fifty-three, received severe blow beneath right eye with the handle of a pump, ten years before. First seen December, 1905. August, 1905, intense pain in the right side of head. At end of December, 1905, diplopia, exophthalmos, conjunctival reddening, systolic murmur. Fundus slightly congested. Vision: Right, 0.4, left, 0.6; paralysis of right abducens. Visual field slightly diminished. Injection in thigh $2\frac{1}{2}$ per cent. gelatin every five days. After 22 injections exophthalmos reduced one-half, with normal motion and complete disappearance of diplopia.

IV. ZELLER: Case report of one operation—patient died of hemorrhage caused by ligature sawing through the artery before it was tied. Zeller's procedure: Ligation of internal carotid as near as possible to the skull in the neck and also the ligation of the artery just proximal to the origin of the ophthalmic artery. Cadaver experiments showed him that it is possible only in exceptional cases to see the origin of the ophthalmic artery and to put a ligature proximal to it without pulling on the carotid. The possibility of a clot caused by the ligature obliterating the ophthalmic artery must be considered.

No danger to the eye is to be expected, collateral circulation is very free. No danger to brain.

V. BECKER: Soldier, wounded by explosion of his gun. Four wounds on the right side of face, two on nose, one at corner of mouth, and another in right eye. Ten days later, left eye protruded, increasing steadily in next few days. Retina showed hemorrhages and the ocular movements became more and more limited until entirely lost. On eighteenth day pulsation appeared. Compression of carotid caused diminution of pulsation. X-ray showed fragment of bone 2×1.5 cm. in the neighborhood of cella turcica and cavernous sinus. Internal carotid ligated one and one-half months after accident. Relief for four weeks, then return of former symptoms, but in eight weeks great improvement. After three months further improvement. Lateral movements of eyeball normal. Vision with a plus 4 = $5/15$.

VI. JACQUES: Man, aged twenty-five, injured in motor-cycle accident by falling against the wheel, striking on right side of head. Base fracture. Three weeks later pulsating exophthalmos. Intense epistaxis nine times in six weeks from right nostril, occurring after any strong effort. Ligature of right common carotid. Three days later improvement, but later return of all symptoms. Still later operative exposure of the inner portion of orbit. A polyp was found in the sphenoidal sinus which communicated with the cavernous sinus. Sphenoidal sinus packed with iodoform gauze which was removed on the sixth day without hemorrhage.

VII. POOLEY: Negro, aged thirty, struck on back of head with a blackjack. Three scalp wounds, one on parietal bone near junction with occipital, one

PULSATING EXOPHTHALMOS

further forward, and another on the temple. Unconscious. Distressing noise in head on recovering consciousness. Two days later all symptoms of arterio-venous aneurism except pulsation. Exophthalmos, injected conjunctiva and lids, blowing murmurs heard over eye and a continuous whirring rumbling sound. Eye could be pushed back. Carotid compression diminished but did not stop bruit. No change in fundus and vision unimpaired. Treated for a few days by pressure bandage and carotid compression. Later, ptosis, exophthalmos, enormous dilatation of conjunctival vessels and lids, pulsation, especially at inner canthus, papillitis with enormous dilatation of retinal vessels. One vein in the lower temporal region seemed to be obstructed; above and below the obstructed part was greatly distended. Noises in head had become greatly aggravated. Occasional violent pain in orbit. No impairment of hearing. Patient refused operation.

VIII. IX. X. KNAPP (discussion of Pooley's paper): Three cases, in all of which the common carotid was ligated. Bruit, exophthalmos and chemosis relieved, but the optic nerve went on to atrophy.

XI. CLAIBORNE (discussion of Pooley's paper): Case like Pooley's. Applied pressure bandage, kept up for eighteen months. Mixed treatment internally. Perfect cure.

XII. BARRETT and ORR: Male, aged fifty, ten weeks before observation fell while intoxicated. Unconscious from 24 to 36 hours. In hospital three weeks. No evidence of organic lesions. Six weeks after injury complained of buzzing in the ears, and a few days later exophthalmos. Vision, 6/36. Lower lid everted, marked exophthalmos in middle line, conjunctiva of lower lid engorged and swollen, fundus veins dilated.

External canthus divided and orbit explored, finger pushed behind eye, where a pulsating mass was felt. Later a marked bruit was heard over temporal bone and the eye synchronous with the pulse. Two days later eye became stationary with many hemorrhages and distended veins in the fundus. Progressed. Ligation of common carotid. Steady improvement, exophthalmos diminished.

XIII. RUBEL: Young man. Three and one-half years ago almost lost vision in left eye and the hearing in both ears following a severe blow on the head. Some months later developed the complete picture of pulsating exophthalmos (left).

Ophthalmic findings: Arteries normally full, veins dilated, stasis. Atrophy of papilla. Numerous yellowish flecks on fundus, from papilla to periphery.

Patient observed for two weeks. Then left common carotid ligation by Kraske. Tension of globe (Schiotz) on both sides before operation, 20 mm. Hg. No difference noted on successive days. Immediately after ligation the tension (left) fell to 8 mm. At close of operation 11 mm. Nine days later, left 15-17 mm. Hg; 17 days later, left 15 mm., right 16 mm. Hg.

Retinal changes cleared up with disappearance of exophthalmos. Nine and one-half months later all right except for optic atrophy.

XIV. E. ELIOT, JR.: Man, aged fifty-one, admitted October 15, 1909. Moderately alcoholic. Ten years ago piece of steel entered right cornea resulting in ulceration and partial loss of sight in that eye. Five weeks before admission was assaulted, receiving blow on left zygoma with some heavy instrument. Unconscious for a short time, bleeding from mouth and fractured nose. Walked home. Left eye was swollen and nearly shut, but gradually better, and seventeen days after injury he had some use of eye. Two weeks ago he noticed protrusion

of left eyeball, and during past week eversion of lower lid. Throbbing pain in eye with each heart-beat and a murmur or buzzing sound could be heard distinctly in left ear. Severe pains shooting from left to right side of head. Dizzy at times. No vomiting.

Examination.—Marked exophthalmos, left eye. Eyelids swollen, between them a ridge of red conjunctiva one inch long and one-fourth inch wide. Eye reacted to light and slightly to accommodation. Pulsations could be seen and felt. Continuous blowing murmur could be heard over entire skull and vessels of left side of neck. This sound was exaggerated with every heart-beat, and loudest over left eye. Ophthalmic examination showed marked swelling of papilla and œdema of retina. Veins enlarged and tortuous. Arteries small.

Operation.—Ligation of common carotid, just above omohyoid. No sign of interference with cerebral circulation. Intracranial murmur ceased and exophthalmos disappeared rapidly; at ten days little remained. Three years later, eye-sight has gradually improved. Continued use in reading results in headache. No exophthalmos.

XV. GIBSON: Showed photographs of a case where he had ligated carotid in 1904. There had been some intracranial operation, during which some trauma was inflicted, and further operative measures were abandoned on account of severe hemorrhage. On admission both eyes were bulging, and the sight of one eye was lost. Common carotid tied, and in course of time patient recovered entirely as far as appearance of eyes was concerned.

XVI. FLEMING and JOHNSON: Man, aged forty-seven, previously good health. September, 1907, fell on back of head. Unconscious for few moments. No reason for fall. Walked home. Well until November, when he noticed he could not see objects placed on left side. Found to be suffering from hemianopia. No proptosis then, but soon afterwards beating noise.

April 19, 1908, noticed that left eye was prominent and inflamed. This increased. April 29, left side proptosis, lids swollen and congested. Chemosis, especially lower fornix. Pupils equal and reacted normally to light and accommodation. All movements of left eyeball are limited. Pulsation of eyeball, bruit, etc. Pulsation and bruit arrested by compression of common carotid. No cranial nerve affected, except optic (left hemianopia), and right hypoglossal, the tongue deviating slightly to right.

May 14, left common carotid ligated with silk in continuity, at level of cricoid. Pulsation immediately arrested, and never returned. Proptosis gradually disappeared. June 10, sat in chair and June 11 became aphasic, with right facial paralysis, tongue deviating strongly to right, and weakness of right arm. Better next day and gradually improved.

September 29, still slight proptosis. No pulsation detected. Faint systolic murmur heard over eye. Conjunctival vessels injected. Left eye vision 6/6. Hemianopia unchanged. No facial weakness, but tongue still deviated to right. Weakness of right hand.

Late onset of cerebral symptoms supposed to be due to extension of clot into some small branches of middle cerebral.

XVII. GWYNNE WILLIAMS: No operation. Male, aged twenty-nine, has had dilated veins over left eye ever since he was a baby. Fell on head when nine and had concussion. Left eye "weak," but became prominent only in last 11 months. Has twice had subconjunctival hemorrhages, when eighteen and twenty-five years old.

PULSATING EXOPHTHALMOS

Exophthalmos, chemosis, eye pushed forward and outward, all motions limited. No diplopia. Bruit, systolic. Eyeball pulsates. Pressure on common carotid diminishes swelling and stops pulsation. No pulsation seen in veins of retina.

XVIII. LAZAREW: Lazarew's case was sixth in Russian literature, among 150 known. Patient, seventeen years old. Three years ago noticed that right eye was becoming more prominent, with noticeable swelling at inner angle and pulsation. Came on suddenly on arising in the morning. No trauma.

Common carotid ligated. Pulsation stopped immediately, but the exophthalmos persisted, and in the evening the patient complained of pain in the teeth of both lower jaws, and a slight pulsation in the eye began again. No improvement after five days, so Lazarew ligated the superior ophthalmic vein.

Lazarew believes that he is the first to perform this operation. Cerebral disturbances followed, but subsided after 14 days. Cure complete.

XIX. SAVARIAUD: Small girl had head squeezed between a large plank and a boat, had hemorrhage from right ear and nose. Later, paralysis of the abducens on the right side, exophthalmos and continuous murmur with systolic emphasis. Slight pulsation. Injections of gelatin after Lancereaux's method failed.

XX. BEDELL: Man, aged thirty-nine, was riding on an open street car, May 31, 1913, which was derailed and thrown against a tree. The man was thrown to ground and struck his head. Next day dazed, with all signs of true fracture of base of skull, bleeding from nose, ears and mouth and vomiting. No paralysis of face, all reflexes normal. Mind cleared in about four days and memory gradually returned. Hearing on left side lost, and slight ptosis of left upper eyelid. Constant dizziness and headache. Five days after accident patient felt something "like electricity" in upper angle of left orbit, which was found to be definite pulsation and bruit. At that time there was marked diplopia, dilated pupil and beginning proptosis.

May 7, 1914, patient complains of constant noise in head and terrible headache. Right eye vision, 20/30. Decidedly proptosed. Outward motion limited. Veins of lids, especially at inner corner of upper lid, prominent and tortuous. Pupil active and normal. Retinal vessels overfull and veins especially. Congestion of disk. No pulsation of globe.

Left eye vision, 20/30. Proptosis more marked than right. Extremely large mass of tortuous and dilated veins on upper lid. In the upper and inner corner of the orbit is a large dilated vessel (2 cm. in diameter) transmitting a distinct bruit. Visible pulsation of globe. Pupil normal. Entire conjunctiva congested. Retinal veins congested and tortuous. No hemorrhages. Field of motion limited. Eyeball turned in 30 degrees, abducens paralysis. Bruit most intense over supra-orbital ridge, although felt over entire head. Systolic blowing murmur heard over same area is stopped by carotid pressure. Left ear, thin gray retracted membrane. Hearing greatly reduced. Large perforation of septum of nose. Wassermann and Noguchi negative.

March 29, pressure on left eye partially reduces it, causes strong pulsation and patient complains of dizziness. Carotid pressure or pressure on the ophthalmic vein deep in left orbit stops pulsation and bruit. Lying down increases headache, but does not affect exophthalmos. Diplopia.

October 4, no improvement. Patient refuses operation.

XXI. G. J. PALEN: Woman, aged sixty-five. October 18, 1908, complained of pain in right eye, extending into head, photophobia and lachrymation. In 48 hours

there occurred a vesicular eruption along course of supra-orbital nerve (right). This eruption disappeared in 3 or 4 days. October 21, pain, which had recurred at intervals, became more intense and she was unable to open the right eye. No inflammation of eye at this time. Had interstitial nephritis, atheroma and hypertrophy of heart for some time.

Examination (November 9).—Marked ptosis, proptosis. Pupil dilated and eyeball deviated outward and somewhat downward. Vision below normal, optic disk swollen, veins tortuous and engorged. For some time prior to her attack she had had a very intense noise in head which was continuous but seemed increased at every heart-beat—"a rushing sound like rushing water." This did not cease until onset of pain October 18. At age of eight she was struck on head by handle of pump, but had no trouble from it. Scarlet fever, whooping cough, varioloid, grippe three times. No acute illness prior to this condition.

Condition rapidly became worse. Bruit heard, plainest over eyeball and right antrum, less intensely so over right side of head, and with diminished intensity downward along side of neck. Had sound of tubular breathing with marked systolic accentuation. Pressure on right carotid checked bruit, and eye could easily be pushed into orbit. Pressure on left carotid gave no result. No pulsation at this time. Refused operation. In bed, recumbent, carotid compression used. November 13, the eye protruded markedly and was fixed in medium position. Marked chemosis, complete ectropion of lower lids, cornea insensitive and dull, swelling of disk very intense. At inner upper angle was a soft compressible tumor and the veins above and to temporal side were engorged. Distinct pulsation felt over this tumor, and beginning pulsation of eyeball noticed. Condition became much worse. Bruit heard over entire head loudest over right orbit and right and left mastoid regions and much louder than before. Potassium iodide in increasing doses. No result from digital compression. Slight improvement but vision was gone. Treatment continued at home. Proptosis lessened and pulsation disappeared about latter part of January. March 1, had severe hemorrhage from left nostril, after which eyeball receded greatly. Bruit still heard over entire head, loudest over lateral sinus. January 24, bruit disappeared, still partial ptosis, slight increase in ocular movements. Vision 0, optic nerve atrophy. No engorgement of veins about orbit or at inner angle.

Peculiarity of this case was the intensity of the bruit along course of the lateral sinus. The intensity of bruit lessened markedly above and below this line.

XXII. MATTHEWSON: Man, aged thirty-two, thrown from top of car October 8, 1910, fracturing base of skull. November 5, left eye proptosed with complete ptosis. Considerable swelling of conjunctiva and restricted motion of globe. Fundus negative. Vision fingers 8 ft. in upper field, lower field lost. No pulsation of globe.

December 20, veins of upper lid much dilated, ball pulsated, slight pallor of nerve, slight dilatation of retinal veins, no bruit, occasional headache.

March 11, vision almost gone. August, condition more marked. Loud blowing murmur heard over greater part of skull.

September 5 common carotid tied. Month later, little proptosis, no bruit or pulsation.

XXIII. BARBIERI: Italian man, aged forty-three. April 24, 1907, had intense pain in temporal region. Next day exophthalmos, and one month later the right eye pulsated. Injection of 5 per cent. gelatin tried without result. October 21, ligature of right common carotid. Exophthalmos and pulsation continued.

PULSATING EXOPHTHALMOS

January 8, 1908, the left common carotid was tied. April 4, when last seen, exophthalmos present, movements of eyeball moderately free, pupil inactive to light, slight headache, subjective noises continued.

XXIV. MAYOR SPENCER: Gunner, twenty-three years old, struck by fist in right eye, June 12, 1906. Black eye, skin not broken. Three weeks later began to have buzzing noises in head, becoming worse. On examination six weeks after trauma, pulsating swelling, with thrill and murmur, detected in orbit. Treated by compression of carotid and calcium chloride internally, but swelling increased in size. Marked proptosis, with some swelling of lids and lachrymation. Pulsating swelling about size of hazel-nut projected under upper eyelid. Expansile pulsation, distinct thrill and loud musical whirring murmur, and it seemed that the main bulk of the tumor was deep in the orbit, while the small swelling was only an offshoot. Vision 6/6 in each eye, slight diplopia on looking upward and to the right. Fundus and conjunctiva normal.

December 5, right common carotid ligated. Pulsation entirely disappeared on tightening the ligature, but a slight thrill could still be felt over the right eyebrow. Pulsation in the small swelling reappeared slightly six days later, not deep in orbit. Excised fusiform dilated vessel. All pulsation and thrill at once disappeared. Well since, and no recurrence (March, 1907). No trace remains except a slight fulness in right orbit.

XXV. ORLOFF: Pulsating exophthalmos developed six months after a deep wound in region of left parietal and temporal bones in a thirty-year-old patient. Successful result obtained after ligating ophthalmic vein in the depths of the orbit after temporary resection of external wall of orbit.

XXVI. XXVII. XXVIII. BUCHTEL: Operated August 13, 1912. Male, struck on head with a pitchfork three months before. Buzzing sound in head, and in a few days left eye protruded. Well-marked exophthalmos, forward and downward. Pulsation of the eyeball and the mass at the upper and inner angle of orbit, with continuous bruit and systolic accentuation over brow and temple. Complained of noise, diplopia and headache. Fundus negative.

Operation.—Incision, eyebrow, angular. Superficial and temporal veins tied and superior ophthalmic ligated as far as possible in orbit. More œdema at first, but no bruit, pulsation or fundus change. Exophthalmos gradually lessened. Vision 20/20.

Also reports two other unrecorded cases. One, a double exophthalmos, cured by ligation of common carotid.

The other, unilateral, died after ligation of common carotid.

XXIX. HALSTEAD and BENDER: Man, twenty-four years old. Wagon-wheel passed over his head just back of the eye, January 29, 1909. Unconscious three days. Left eye bulged more after accident than on entrance to hospital, when it was turned sharply toward nose and appeared paralyzed. Lids swollen and impossible to close upper lid, move the jaw or to swallow. Roaring noises synchronous with the heart-beat could be heard from the time patient regained consciousness until he entered hospital. In bed two weeks after accident, during which sight in left eye became much impaired.

Examination (August 27, 1909).—Left eye turned in 45 degrees and very prominent, $\frac{2}{3}$ inch further forward than the right. Veins on upper lid very large and tortuous. Blood-vessels of sclera also dilated. Cornea vascular, and over a 4 mm. area in centre is a fairly dense cicatrix. Vision: right, 20/20; left, 20/30. October 10, pulsating tumor felt over lid and inner angle of orbit.

Bruit heard over left temporal region and roaring noises complained of by patient, heard most distinctly over left ear. October 14, left internal carotid ligated near origin with chromic gut. At present left eye turns in and there is some exophthalmos but no bruit.

XXX. LANE: Male, struck on head by brick, fracturing nose, three months ago. Twelve days later ectropion of lower lids, marked œdema. Vision: right eye, 8/200; enormous dilatation, retinal veins; small hemorrhages about disk. Pulsation, bruit, exophthalmos. Blowing sound, left ear. Pulsation continues over left temporal region with accentuated systolic murmur. Only general treatment and potassium iodide. June 10, patient sat up for first time. Five A.M. June 11, became aphasic with right facial paralysis. September 2, no pulsation, faint systolic murmur, vessels of conjunctiva bright red color. Vision: Left eye, 6/6.

XXXI. MAHER: (1) Man, aged thirty-five. Ten months ago had had a blow on head with a stick. Was unconscious 30 hours and dazed a week. Three weeks after injury right eye began to protrude and throb with marked pulsation, controlled by pressure on right common carotid. Bruit over eye and temporal region. Marked engorgement conjunctival vessels, œdema of conjunctiva, pupil dilated, retinal veins dilated and tortuous, marked œdema of optic disk and retina. Headache and whirring noise in head. Right internal carotid tied. Pulsation ceased at once. Exophthalmos diminished. Three years later no exophthalmos, slight pallor of disk, and only occasional headache.

XXXII. (2) Man, aged nineteen, fell 45 feet, fracturing base of skull. Unconscious several days. Six weeks after injury left eye began to protrude and for some weeks progressed, then gradually subsided. The right eye became more prominent. Pain and noises in head. Right eye proptosed and convergent, conjunctiva œdematous, vessels full; limited motion of globe up and down, no motion outward; pupil normal, retinal vessels slightly tortuous and dilated. Vision, 5/18. Left eye not proptosed, movements up and down limited. Pupil dilated. Disk pale. Vision, 5/21. Loud bruit over right eye and temple. Left internal carotid tied. One month later, marked subsidence, eye moved up and down but not out, headache better, but bruit persisted, vision same.

XXXIII. WEINKAUFF: Widow, aged eighty-four, with no known reason became sick, April 16, 1908, with severe headaches; next day frequent vomiting appeared, and unconsciousness. Consciousness returned after a few days, but speech was still somewhat confused at first. It was noticed that the left eye was markedly pushed forward, and shortly afterward the right eye became affected in the same manner. The patient complained of serious disturbances of vision.

Patient seen first on May 5, 1908. Consciousness normal. No headaches now and none present subsequently. Ringing in the ears exists unchanged since several years, deafness for a longer time. Old age pronounced. Arterial rigidity is not exceptionally pronounced, pulse irregular. Remained in about this condition for next six months, then died from sudden cardiac failure.

Examination.—Slight facial œdema, also œdema of the overhanging upper lids. Globes directed downward, slightly divergent. Completely immovable and proptosed. They could not be pushed backward. The œdematous bullar conjunctiva pushed out between the lids. Media clear. Papillæ are cloudy and swollen. Numerous small hemorrhages of the retina. Retinal veins dilated only moderately and slightly tortuous. Sensibility of cornea gone. Fingers counted on both sides at $\frac{1}{2}$ M.

PULSATING EXOPHTHALMOS

In June the œdema and exophthalmos began to go down slowly. In the upper inner angle pulsation is clearly felt, deeply situated. Bruit heard synchronous with the arterial pulse over the upper part of the orbit, changing to a blowing murmur during diastole, heard loudest over nasal side. This murmur gradually increased in intensity in the next few days, "*bau-sch, bau-sch.*" The patient did not notice this murmur, complaining only of the former continuous singing in the ears. Left vision now 0.

July, pulsating nodules began to form at inner and upper angle, which gradually became smaller. August, right side showed hardly any pulsation. Compression of the right or left carotid produced no changes. Double carotid compression not tried. Pulsation of the bulb itself was not noticed, nor was pulsation of the retinal vessels seen. October, pulsation gone entirely. November, bruit completely disappeared. No exophthalmos. Right eye counted fingers at 2 M.; the papillary swelling had gone down. Left eye entirely amaurotic. Movability of the bulbs remained limited. Death in December. No autopsy.

XXXIV. HILDEBRAND: Young man, in 1893, fell from a ladder and broke his arm and sustained cerebral concussion. Blind in left eye on recovering consciousness. Four months later the left eye protruded slightly. Pupils dilated and motionless, optic nerve white and glistening.

Diagnosis.—Laceration of optic nerve. One-half year later the globe was pushed very far out. Upper eyelid swollen with marked enlarged vessels. Root of nose swollen and pulsation was felt there. Pulsating vessels ran backward from here. Globe could be easily and painlessly pushed back, and was directed inward and downward. Retinal veins dilated and tortuous. Arteries normal. Loud whistling sound heard over entire head with stethoscope, loudest between outer angle of left eye and left ear. Bruit disappears when carotid in neck (left) is compressed. Patient complains of the bruit, which he hears strongest in front of left ear.

Treatment.—Carotid compression tried one year after injury, for nine weeks for one hour a day, carrying out the same treatment himself later at home. No result one-half year later. Patient seen by Hildebrand seventeen years after injury. Above condition. Globe shows slight pulsation, and hardly moves upward and outward. Lids are not swollen or œdematous. Vessels of forehead greatly distended and tortuous. Right eye normal, veins slightly distended. Both superior ophthalmic veins are involved. No operation.

XXXV. HALSTEAD: Male, aged thirty-six, struck twice on left temporomalar region with a hard instrument, February 10, 1910. Unconscious a short time, then walked home. Blood from nose and ears. Facial paralysis next day and roaring in the ears. Two months later, when left eye was enucleated for panophthalmitis, the orbital contents prolapsed. Vision, 20/40. Diagnosed as pulsating tumor of base of brain, probably aneurism. October 5, 1910, stump of left eye removed. Right eye signs of beginning venous stasis. Roaring in ears heard in head; long, loud bruit over malar regions. Common carotid and two divisions of superior thyroid ligated. Bruit disappeared immediately. No brain symptoms.

XXXVI. RANSOHOFF: Man, blow on right temple during fight. No unconsciousness or dizziness (October 18, 1905). On November 28, he suddenly noticed that he could not see out of right eye, which became swollen and prominent, until within two weeks he could not close the lid. Ringing and buzzing in the head, occasionally pain in forehead.

Examination.—Man, aged twenty-two, farmer. Healthy. Abducens paralysis. Pulsating exophthalmos. Ocular media clear.

Operation.—Common carotid, external and superior thyroid tied with catgut. Superior thyroid divided, common carotid divided. Abducens paralysis persists. Vision has improved much, subsequently the central scotoma disappeared, and neuritis cleared up. Cure.

Diagnosis.—Arteriovenous aneurism of internal carotid, rupture of abducens.

XXXVII. R. J. SCHAEFER: Woman, aged seventy-four, suddenly taken with vomiting and distress January 10, 1907. Went to bed. Soon after felt severe headache, spreading to right eye. Next day noticed a brownish circle around the lids of right eye, and January 12 paralysis of upper lid occurred. No unconsciousness, but insomnia. Noises in head, and her previous deafness grew greater. Sees well. No previous serious illness.

Examination.—Nothing in heart, lungs or other organs. Several suffusions on right side of face, especially around right eye. Ptosis-exophthalmos, chemosis. Total ophthalmoplegia. Sensitiveness to pressure on the globe. Pulsation not present. Amaurosis. Retinal ischæmia.

Operation (January 21).—Chloroform. Protrusion now tremendous. Pulsation now evident. Bruit over right eye and side of head. Attempt made to ligate superior ophthalmic vein, according to Sattler's method. Great hemorrhage, and the vein could not be found. Tampon. Tried to find inferior ophthalmic vein. Could not. Had to tampon and give up operation.

Digital compression of common carotid tried at intervals. Suddenly, January 28, she could sleep and the bruit and noises no longer existed. Thrombosis of sinus thought to have occurred. The pulsating exophthalmos continued and the eye was nearly dislocated from the orbit. Enucleated January 30. Did not ligate common carotid at first (in disease) because he feared to do so on account of general arterial sclerosis. Died about February, 1910, from arterial disease.

XXXVIII. OPPENHEIMER: Had seen a case (erecile tumor) in which the common carotid was ligated. Secondary hemorrhage resulted fatally.

XXXIX. KRAUPA: Man, twenty years old, jumped from a spring board into a swimming pool. On coming to the surface he noticed a remarkable ringing in his left ear, which became more pronounced in the next few days. Also began a typical pulsating exophthalmos of left eye. Patient very alcoholic, otherwise sound. Short systolic bruit at apex. Hearing was slightly impaired in left ear. Typical pulsating exophthalmos in left eye. Media clear.

Digital compression carried out for a long time, and then Weil ligated the common carotid. Three months later high-grade exophthalmos still persisted, but the pulsation and the subjective symptoms have disappeared since ligating.

Five years later he came complaining of abdominal pain and examination showed very slight exophthalmos. He confessed having had syphilis one year before his eye trouble. Wassermann positive.

Cornea clear, movement normal. Pupils unequal, incomplete reflex. Thickening of walls of retinal veins, which was not altered by 606 and other treatment for two years. Increased blood-pressure in the veins assumed to be the cause. No exophthalmos or pulsation, but the retinal veins are still thickened.

XL. C. S. MERRILL (personal communication to Bedell): Woman, aged fifty, fell from wagon, striking the back of her head, July 5, 1909. When seen had left-sided chemosis, external exophthalmos, and pulsation. Aneurismal bruit. Compression of carotid stopped the bruit. Vision: right, normal; left, nil.

PULSATING EXOPHTHALMOS

Dr. A. W. Elting ligated left external carotid. All symptoms relieved and eyeball returned to normal position. Some months later, vision: right, 20/20; left, objects to outer side; optic atrophy.

XLI. SANTOS FERNANDEZ DEZ BALBUENA: Man, aged forty-seven. Forty-two days before observation he was struck by a hammer, unconscious for 3 days. On recovering consciousness he had noise in the head, with moderate exophthalmos and ptosis. Pupil normal. Conjunctiva congested. Compression of common carotid caused disappearance of symptoms. A week after observation gelatin injections were started (intravenous), 2 per cent., and 2 per cent. NaCl. One month later the condition was much better. Pulsation stopped and exophthalmos disappeared.

XLII. LYSTAD: Boy, aged fifteen, stoker on steamer, was wounded August, 1902, by a revolver in the right nasal aperture. Right-sided ptosis noticed on admission to hospital, besides a left spastic hemiparalysis with incomplete anæsthesia and much disturbance of hearing in left ear. Left hospital after three months and eight months later resumed his work.

About two years after his accident he gradually began to notice swelling over the right eye, and in the next year gradually increasing exophthalmos and bruit. Patient states that the swelling is greater just before a storm—"barometer." Five years after trauma he received a blow with the fist over the right eye. Came to clinic for treatment July 27, 1907.

Typical pulsating exophthalmos. Movement of eyes normal. Stasis of retinal veins, no pulsation. Subjective and objective vessel bruits disappear almost entirely by compression of right carotid.

September 17, 1907, right internal carotid was ligated. Not sufficient, so the external carotid and jugular vein (internal) were also ligated. Great improvement seen at first, subsided during the next week, and in the beginning of 1908 the pulsation and exophthalmos were about as before ligation, and patient was unable to work.

January 24, 1908, orbital operation performed (Prof. Schiotz). The pulsating mass in upper inner angle was ligated. There were a great number of very tortuous, thin-walled veins. Operation difficult. On removing dressings next day there was seen an enormous protrusion of the bulb and its surrounding structures. Intense headache and pain in eye. Subjective bruits unchanged, pulse slow, sensorium clear.

A slight swelling in the neighborhood of the left eye subsided after a few days. After three weeks the protrusion was distinctly smaller; pulsation and objective bruits disappeared. The subjective bruits were noticeably less, but severe headache and slow pulse persisted.

The exophthalmos slowly disappeared during the following weeks, the swelling over the eye grew less tense, and the pulse normal.

Two months later he stood up. Slight posterior synechiæ, fundus not clear, hemorrhages. Tension increased, 51 mm., Schiotz. Fingers at 2 M. and field of vision concentrically greatly narrowed. After several months was able to work. Absolute glaucoma.

Eye enucleated at request of patient December, 1908. No headaches subsequently. The subjective bruits come at times but very slightly. Otherwise normal.

XLIII. RISLEY: (1) Knocked unconscious by fist blow on the ramus of right jaw. Four weeks later pain in head, diplopia and confusion. Proptosis of right eyeball about 10 mm., swelling of lid, conjunctiva chemotic with full

veins near inner canthus. Motion limited except downward. Systolic pulsation best heard over right eye. Vision, 6/12. X-ray negative. Still under observation.

XLIV. (2) Man aged thirty, three years before had had his head caught between trolley car and express wagon. Unconscious seven weeks. Abducens paralysis, slight proptosis of right eye. Loud blowing systolic bruit heard over entire skull but loudest over right eyeball and left frontal. Bruit lost on right carotid compression. X-ray negative. Still under observation.

XLV. HASLAM and HIRD: Woman, aged twenty-four, husband died of pulmonary tuberculosis. No history or signs of syphilis. Two days ago had pains round her right eye, and noises in her head. Came on suddenly. Went to work next day and noises became louder then and the eye became prominent. No pain. Sight was bad but improved later. Went home to bed and was sick several times.

Examination.—Proptosis (right). Subcutaneous and subconjunctival ecchymoses. Pulsation, eye pushed forward in systole. Double bruit heard over eyeball. Visible pulsation over right side of neck along great vessels. Bruits could be heard over whole of skull. Pressure on right common carotid stopped noises (subjectively), but they could still be heard by stethoscope. Eyeball freely movable. Pupils equal and react normally. No signs of arterial disease. Six days later (after admission) she began to have paralysis of external rectus.

Six weeks after onset right common carotid was ligated at level of cricoid. Thyroid gland much enlarged. All symptoms improved except pulsation (very slight), and patient could still hear slight noise, and double bruit had become only systolic. Ten days later the noises and murmurs became worse, and next day the double murmur was present again. Abducens paralysis still persists.

Right internal angular vein was ligated one month later. Noises much less for three days afterward, and no thrill or pulsation was present. Not followed by thrombosis of cavernous sinus.

Eight months later patient has proptosis, pulsation, abducens paralysis, congestion of veins, bruit. Hearing on right side is defective. No visible change in optic disk. Right vision, 6/24 (with glass). Right fundus shows congestion. Pulsation in arteries of neck above ligature.

XLVI. GINSBURG: Boy, aged eighteen, struck on head with an iron object, August 26, 1910. Unconscious 15 minutes. Hemorrhage from mouth and nose. St. Praes (three days later). Complains of headaches, very severe and worse at night. In the left eyebrow is a small skin wound. Bony rim is sensitive and swollen. Large ecchymosis under left lower eyelid. Left eye otherwise normal. Right eye proptosis, immovable, lids congested. Pushing the globe backward causes pain. Bulbar conjunctiva is not sensitive in the nasal region, also on temporal side. Pupil medium wide, light reaction gone (direct and consensual). Disk cloudy, boundaries hazy. Fundus congested. No pulsation of vessels. Veins dilated and tortuous, arteries contracted. No hemorrhages. Amaurosis, vision 0.

Diagnosis.—Fracture of base and rupture of optic nerve in optic canal. September 4, strong pulsation in retinal vessels noticed for first time. Pulsation of globe, synchronous with heart systole. Soft, blowing murmur heard over eye. Complains only of severe headaches. Pulsating exophthalmos.

September 10, complains of noise in right half of head, disturbing sleep. Skin over temple, upper lid, and forehead anæsthetic. Cornea and conjunctiva

PULSATING EXOPHTHALMOS

insensitive. Compression of right common carotid causes subjective and objective bruits to disappear.

December 7, ligation of common carotid below omohyoid (Prof. Schimanowsky).

December 8, same bruit, but weaker.

December 9, blowing bruit over forehead.

December 12, proptosis unchanged, no infection in wound.

Operation (March 27, 1911).—Ligation of vena angularis, frontalis, supra-orbitalis and palpebralis superior. All these veins divided. Could not see the superior ophthalmic vein on account of the thickening of other veins, especially the lachrymal. Ophthalmic vein grasped with Pean, also lachrymal. Levator palpebræ superioris and tendon of the trochlearis divided to allow access to the ophthalmic vein. Peans left in place.

March 30, bleeding from left ear. Proptosis greater than before operation. St. Praes, April 17. Complete ptosis. Sensibility of skin and cornea slightly improved. Proptosis entirely gone. No ocular mobility. No pulsation. Vision, 0.

Microscopic examination of excised veins shows thickening, three layers. Hypertrophic process is especially evident in middle layer, which consists of strong muscle fibres. Weigert's stain for elastic tissue demonstrated its presence.

XLVII. FRIEDENWALD: R. S., colored, aged twenty, applied for treatment November 11, 1909, because of pain in right eye, which she said had been bulging out of socket for eleven or twelve years. Pain had begun in past year, condition otherwise unchanged. No history of trauma. For some months had heard a thumping noise in right ear, especially at night. Hearing perfect.

Present Condition.—Right eye displaced forward and downward. It is very prominent and pulsates so markedly that pulsations can be seen many feet away. Easily palpable. Right eye about 12 mm. lower than left, and forced forward at least 5-6 mm. with each pulsation. Eyeball easily and painlessly pushed back into socket. Vision: Left, 16-15; right, 16-200. Ocular movements in right eye normal except upward. Diplopia. Pupils equal and react to light. Lids, conjunctiva and anterior part of eyeball are normal. No tortuosity or congestion of retinal vessels. Right disc paler than left. No bruit about the orbit. At the posterior margin of left sternomastoid is a short well-marked blowing sound systolic. At times a blowing sound is heard along margin of right sternomastoid. X-ray shows enlargement of pituitary fossa, with irregularity. Right orbital cavity larger than left.

XLVIII. RECLUS: Woman, syphilitic, entered hospital July 18, 1906, for affection of the orbit. Treated for several months previously for syphilis. Five years ago began having rebellious headaches, especially at night.

February, 1906, was taken suddenly with fever and violent pains in the head, diagnosed as meningitis. Then the inner angle of the left eye began to be a little more prominent than the right, prominence consisting of pulsating vessels. One night later she was awakened by a sound like a locomotive blowing off steam.

Examination.—Exophthalmos, swelling œdema of upper lid, with a network of dilated vessels in it. Pulsation and thrill over these tissues, and down the carotids on both sides. Bruit heard everywhere over skull. It was a continuous whistle, with systolic accentuation. She complained besides of another bruit, like the chirping of a bird. Sugar and albumin in urine.

Digital compression of common carotid. Slight betterment, but later recurred.

Gelatin injections, Lancereaux and Paulesco, following the first therapeutic suggestions of Carnot in the coagulating power of gelatin. Lancereaux cured a case by this method and presented him to the Academy. Twenty-one injections given. One per cent. solution of gelatin in serum at first, then 2 per cent., as the 1 per cent. was found not active enough. Five per cent. is painful and causes a rise of temperature. Two per cent. caused a slight rise. Injection into the muscles, not subcutaneous. Slight improvement was noted. Twenty-one more injections were given, and the result was more encouraging. Altogether, 81 injections of 40 grammes of solution were given, when she was taken with complete ophthalmoplegia (left) and ptosis. Regarded as specific and treated with gray oil injections. No improvement, and she is blind, with retinitis of that eye. Gelatin injections resumed, and after the fourth one she had acute swelling of upper lid with pain. Ice used locally. Pain disappeared and the vessels felt hard, with no pulsation. Pulsating exophthalmos disappeared. No chemosis, or vascular tumor. The intracranial whistle persisted and the attacks of headache. Glaucoma of left eye.

Left common carotid ligated March 19, 1908. Intracranial bruit disappeared next day. Two months later well except for ptosis and ophthalmoplegia and blindness.

May, 44 days after operation, suffered an apoplectic stroke and died.

Postmortem.—Cavernous sinus full of hard clots and dilated to size of small nut, with the internal carotid ruptured 4-5 mm. Common carotid and internal carotid empty down to the place of ligature, where there is a clot about 2 cm. long. A second rupture of internal carotid into cavernous sinus existed on the other side, fresh. She had been having symptoms on right side for a short time, bruit, headache and pain in right globe.

XLIX. WILDER: W. C., aged forty-two, American, admitted October 31, 1910. Three weeks previously was waylaid by a thug and struck over right eye. Unconscious. On recovering noticed lids of both eyes were swollen. Sight not impaired, but diplopia was present. Severe pain in right side of head, intermittent. These attacks became more frequent and severe and he came to hospital. Noticed roaring in ear on recovering consciousness, like a steam exhaust. Right eyeball began to protrude and swelling of lids did not diminish. The pain in the head became constant, radiating to back of the head and spine.

Examination.—Right exophthalmos, conjunctiva swollen and oedematous. Conjunctiva veins engorged. Marked distention of angular vein at superior border of orbit. Cornea clear. Pupil dilated and inactive to light and accommodation. Mobility of eyeball reduced to slight abduction only. Levator palpebrae also powerless. Vision: Right, 20/60; left, 20/20. Fundus normal except for engorged veins. Optic disc redder than normal. Left eye normal. Hearing normal. Marked bruit, systolic accentuation, heard over right side of head and eye, most pronounced over zygomatic arch. At times faintly heard over left temple and eye. Bruit and subjective noises stopped on compression of common carotid. It was doubtful whether there was ever any pulsation of orbital contents, even when leaning over.

Operation (November 10, 1911).—Dr. A. W. Bevan. Ligation of common carotid. Bruit stopped immediately. On recovery from anæsthetic noises were not heard. Pain in head persisted for a week and gradually subsided. Exophthalmos disappeared slowly. Swollen conjunctiva required massage and astringents. Mobility of eye slowly returned, pupil became normal. Vision, 20/30 at

PULSATING EXOPHTHALMOS

five weeks. Wilder thinks this was an aneurism of the carotid (cavernous portion), not communicating with the sinus.

L. (2) C. O., aged thirty-eight, laborer, admitted November 22, 1910. Struck on back of head by beer-bottle 5 or 6 months ago. Unconscious for some minutes. Again became unconscious, trephined. Regained consciousness after operation. Left hospital well after three weeks. Again struck on back of head with iron bar, unconscious. Scalp wound sewed, well. Two weeks later began to have headaches and noises in head and right ear. These continued steadily, and five weeks later noticed protrusion of right eye, later pain and lachrymation. Came to hospital.

Examination.—Exophthalmos (about 10 mm.), directed downward and outward. Mobility of right eye limited to abduction and outward rotation. All muscles supplied by third nerve seemed to be paralyzed. Fourth and sixth normal. No facial palsy. Pupil dilated. Ptosis. Chemosis of conjunctiva and fornix, with engorgement of veins. Angular vein not markedly distended. Fundus normal except for some engorgement of retinal veins. Vision: Right, 20/40; left, 20/30. Tension of right slightly plus. High pitched bruit, synchronous with heart-beat, heard over entire head, but loudest over temporal region of right side of right eye. Blowing bruit, accentuated in systole. Very slight pulsation of orbital contents seen and felt. Orbital pain and roaring in head, "like a waterfall." Hearing normal.

Bruit and head noises ceased on compression of common carotid.

Diagnosis.—Aneurism of internal carotid in or near the cavernous sinus.

Operation.—Ligation of common carotid. Dr. A. D. Bevan, December 12, 1910. Bruit stopped on ligation. Patient relieved of noises and pain at once. Exophthalmos gone in two weeks. Chemosis better. Partial recovery from the third-nerve paralysis. Pupil still enlarged and immobile. Retinal veins still enlarged. January 28, 1911, hissing noises began occasionally, accompanied by exophthalmos, receding again. Some weeks later faint bruit heard over right mastoid and temple.

Internal carotid ligated April 5, 1911. When ligature was placed around vessel bruit did cease (high bifurcation). Found and ligated. Paralysis of muscles of left forearm and hand, difficulty in speech. No amnesia. Gradual return to normal. Exophthalmos still slightly present. Mobility good, right pupil 1 mm. larger than left, and mobile. Vision: Right 20/50; left, 20/20.

LI. IPSEN: Woman, aged forty-nine, came to Rovsing's service June 1. Enlarged cervical glands of left side. Two miscarriages.

Lately has had severe headaches back of ear twice a year, causing shooting pains at the vertex of the head, and accompanied by vomiting. Normal in interval.

March, 1911, she fell against a tree and injured left side of head and neck, but there were no signs of basal fracture or unconsciousness.

May 7, suddenly taken sick from no apparent cause. Intense pain in right side of head, with buzzing and sounds like machinery in operation heard. Vomiting.

Examination.—Nothing abnormal seen, but next day the right globe was protruding, conjunctiva injected and eyelids were swollen. These symptoms increased in intensity in next few days, and globe became immovable. Ten days later pulsation of globe and eyelids was noticed. This pulsation stopped upon

compression of common carotid artery. May 29, the left eye showed slight proptosis and pulsation, ceasing when right common carotid was compressed.

Examination (June 1).—Same findings as above. Intra-ocular tension increased. Ophthalmoscope showed veins dilated to twice normal size, arteries normal. Total ophthalmoplegia. Vision of left eye was 5/12. Wassermann reaction was negative.

Operation.—Dr. Theodore Rovsing. Ligation of right common carotid. Immediate subsidence of objective symptoms. Discharged July 1, 1911. Recovered quickly, and now can read fingers at a metre's distance, but only on the temporal side. No headache. Nevertheless, she feels a continual buzzing in the left ear, but this is checked by pressure on left common carotid.

LII. SILVAN: Boy, aged sixteen, sent to specialist for a disturbance of right eye. October 20, 1913, while building a narrow bridge, he was thrown out from the bridge, against right side of head and neck, the left side of his head struck against a loaded wheelbarrow. Unconscious, and remained comatose for an entire week. Immediately after trauma, hemorrhage from nose, ears and mouth, and successively delirium, vomiting, without any general or circumconvulsive phenomena. At return of consciousness remembered nothing of accident, but psychic activity returned shortly, with no disturbance of speech or general motility or sensibility. From the beginning he noticed a painful continuous blowing and rumbling noise in head, more accentuated to the left in neighborhood of ear, like a jet of steam, with rhythmical accentuation with the radial pulse. This bruit was lessened without disappearing entirely, with little variation in time, when pressure was applied to carotid area. At the same time patient and family noticed that the right eye was more bulging, and more inflamed than the other, and that pressure above this gave distinct pulsation with systole, and stopped the subjective systolic bruit. Facial paralysis of left side from beginning. A month after injury the vision of right eye began to fail. All the ocular muscles were intact; besides exophthalmos there was chemosis to a marked degree. Patient said the visual disturbance began with slight degree of pain, with the impression of confusion of near objects, without diplopia, or abnormal sensations nor painful phenomena of any kind. This progressed gradually and became worse, and at the end of four months after accident vision was reduced to light perception.

Examination.—No visceral lesions. Healthy. Reflexes normal, intelligence and memory normal, motor and sensory perceptions normal. No headache or dizziness. No disturbance of walking or equilibrium. Exophthalmos directly forward. Tension slightly increased. Injection of bulbar and ocular conjunctiva, without chemosis or dilation of varicose veins. Upper lid slightly succulent and thick. Cornea not opaque. Pupil dilated and did not react to light or accommodation. Examination of fundus showed papilla inflamed greatly, edges sharply defined. Central vein of retina congested, turgid and tortuous. No hemorrhages. Vision was reduced to simple perception of light. Globe movable upward and downward, and outward, but paralysis of internal rectus. Pressure on the globe only moderately reduced the protrusion, and produced an acute sensation of pain, and a light thrill was noticed synchronous with carotid pulse, which corresponded with the bruit, accentuated with each pulse-beat, resembling blowing off of steam, incessant and disturbing, felt in skull, in temporo-auditory region. Stethoscope over whole skull, but especially over orbit, heard a bruit, soft, blowing, systolic accentuation slightly rough. This was

PULSATING EXOPHTHALMOS

heard along the course of the great vessels along the right side of neck. Heart normal. The bruit, both subjective and objective, the thrill simultaneous with pulsation of the ocular globe when depressed, disappeared immediately and completely with compression of right common carotid, but was unaffected by pressure on left. Vision: Right, $\frac{1}{2}$, field of vision normally limited; left, normal. Olfactory nerve intact. Trigeminal normal. Vision, left paralyzed in all its branches. Ptosis. Eye closed. Palate (soft) half paralyzed and deviated. Other nerves normal.

April 28, Prof. Giordano ligated common carotid just below bifurcation. During the operation one could clearly demonstrate the stopping of the thrill and pulsation of ocular globe when it was depressed. The patient on recovery felt no longer the rumbling and whistling in the skull, and by the evening of same day said that he could distinguish neighboring objects in a confused and uncertain way, which a week before he could not possibly discern. Vision progressed normally and rapidly, so that within one week from the operation the patient said that he could distinguish clearly objects near and far with precision, as before accident.

Examination (May 18).—Showed O. D. V., $\frac{2}{3}$, emm. O. S. V., $\frac{2}{3}$, field of vision normal in both. Slight ptosis. Exophthalmos noticeably reduced. Conjunctival veins less injected. Eye could be pushed back without thrill or pain. Pupil moderately dilated and reacting well. Papilla less congested. Retinal veins less tortuous and injected than before. Shining white spots with circinate arrangement near the papilla and macula, resembling the spots of albuminuric retinitis. Bruit and whistling in pre-orbital region disappeared shortly and definitely. Muscular exercise produced a very slight bruit over carotid region, not affected by posture of head, not subjectively noticed.

REFERENCES

- Bodon: *Deutsche Zeitschr. f. Chir.*, vol. li, p. 605.
Ballin, M.: Pulsating Exophthalmos with Successful Ligation of Carotid. (Detroit M. J., 1905-1906, p. 20.)
Barbieri: Exoftalmia pulsatil bilateral. *Archivos de Oftalmologia Hispano-Americanos*, 1909, p. 9.
Barlay, J.: Exophthalmus pulsans. *Ungar. med. Presse*, 1905, vol. x, p. 216.
Barrett and Orr: Case of Traumatic Pulsating Exophthalmos. *Intercolonial Medical Journal of Australia*, 1909, p. 492.
Beauvois, A.: Traitement de l'exophthalmie pulsatile par la methode Lancereaux-Paulesco. *Rec. d'opht.*, 1907, 3s, vol. xix, pp. 337-353.
Becker: Traumatic Aneurism of Internal (Cerebral) Carotid with Pulsating Exophthalmos. *Arch. of Ophth.*, 1908, p. 635.
Buehtel, F. C.: The Treatment of Pulsating Exophthalmos with Case Report. *Ophth. Rec.*, 1913, vol. xxii, pp. 75-79.
Bull, C. S.: Pulsating Exophthalmos Traumatic. *Tr. Am. Ophth. Soc.*, 1903.
Carreras-Arago: Exophthalmos from Traumatic Aneurism of the Ophthalmic Artery, Cured by Digital Compression of the Carotid. *Rev. de cien. Med.*, 1887, vol. xiii, p. 97.
Clark, H. E.: Case of Pulsating Exophthalmos. *Glasg. Med. J.*, 1887, 4s, vol. xxviii, p. 270.

- Cunningham: Report of a Case of Gradual Occlusion of the Common Carotid Artery in the Treatment of Pulsating Exophthalmos. *J. Am. M. Ass.*, 1914, vol. lxii, pp. 373-374.
- Despaquez: *Bull. Soc. Franc. d'Ophth.*, n. s. xix, 303-308.
- Eliot: Ligation of Common Carotid for Pulsating Exophthalmos. *ANN. SURG.*, 1912, vol. lv, p. 454.
- Evans, J.: Pulsating Exophthalmos. *Brit. M. J.*, 1906, Pt. 2, p. 1305.
- Eissen: *Archiv. f. Augenheilkunde*, 1890.
- Eysen: Ueber die Behandlung des traumatischen pulsierenden Exophthalmus. *Inaug. Diss. Berl.*, 1908.
- Fernández des Balbuena, J.: J. Tratamiento de la exofthalmia pulsátil par les inyecciones intravenosas, de suero gelatinizado. *Arch. de ofthal.*, 1913, vol. xiii, p. 72-75.
- Flemming, P., and Johnson, R.: Traumatic Pulsating Exophthalmos Treated by Ligation of the Common Carotid Artery. *Proc. Roy. Soc. Med.*, 1908-1909, Pt. 2, Clin. Sec., pp. 14-16.
- Friedenwald, H.: A Case of Pulsating Exophthalmus, Without Bruit. *Am. J. Ophth.*, 1911, vol. xx, p. 654.
- Gibson, J. L.: Pulsating Exophthalmos; Postmortem. *Australas. M. Gaz.* 1905, vol. xxiv, pp. 107-109.
- Gifford, H.: Pulsating Exophthalmos Treated by Excision of a Dilated Orbital Vein. *Ophthalmol.*, 1907-1908, vol. iv, pp. 20-25.
- Ginsburg, J.: Beitrag zur Behandlung des pulsierenden Exophthalmus. *Klin. Monatsbl. f. Augenh.*, 1912, Pt. 2, pp. 698-712.
- Golowin: *Zeit. f. Augenheilkunde*, 1890.
- Halstead, A. E.: Double Pulsating Exophthalmos: Report of a Case. *Surg., Gynec. and Obst.*, 1911, vol. xii, p. 298.
- Halstead, A. E., and Bender, A. J.: Pulsating Exophthalmos, Ligation of the Internal Carotid. *Surg., Gynec. and Obst.*, 1910, vol. x, p. 55.
- Hansell, H. F.: Pulsating Exophthalmos: Successful Ligation of Both Common Carotid Arteries: Death. *J. Am. M. Ass.*, 1905, vol. xlv, p. 536.
- Hasse, C. G.: Pulsierender Exophthalmus des rechten Auges, Heilung durch Bindung der Arteria Carotis Communis. *Arch. f. Augenh.*, 1886-1887, vol. xvii, pp. 25-30.
- Hildebrand: Ein Fall von Exophthalmus pulsans nach verletzung. *Aerztl. Sachverst-Ztg.*, 1912, vol. xviii, pp. 10-12.
- Hird, B., and Haslam, W. F.: A Case of Spontaneous Pulsating Exophthalmus. *Lancet*, 1909, Pt. 1, p. 462.
- Ipsen, J.: Et tilfaelde of exophthalmus pulsans. *Hosp.-Tid. Kbenh.*, 1912, 5R, vol. v, pp. 1009-1017.
- Jack, E. E.: A Case of Pulsating Exophthalmos, Ligation of the Common Carotid. Death; Pathological Report by F. H. Verhoeff. *Ophth. Rec.*, 1907, vol. xvi, pp. 463-469.
- Jacques: Exophthalmos pulsatile traumatique, avec epistaxis grave, guéri par la compression directe transsphenoidale du sinus caverneux. *Revue heb. de laryn. d'otol. et de rhin.*, 1908, p. 72.
- James, R. R., and Fadden, W. F.: Two Cases of Pulsating Exophthalmos in which the Carotid Artery Was Ligatured. *Lancet*, 1912, Pt. 2, p. 237.
- Kraupa, E.: Zur Kenntnis der Erkrankung der Netzhaut-Gefäße bei pulsierenden Exophthalmus. *Klin. Monatsbl. f. Augenh.*, 1911, vol. xlix, Pt. 2, pp. 191-196.

PULSATING EXOPHTHALMOS

- Kennedy, R.: Case of Traumatic Exophthalmus Pulsans; Ligature of Common Carotid; Cure. *Glas. M. J.*, 1904, vol. lxii, pp. 426-430.
- Lane, F.: Pulsating Exophthalmos. *Ann. Ophth.*, 1911, vol. xx, p. 226.
- Lewis, F. P.: Pulsating Exophthalmos, Ligation of Orbital Artery; Recovery. *Ophth. Rec.*, 1907, vol. xvi, pp. 66-69.
- Lystad, H.: Traumatisk exophthalmus pulsans, Heibredet ved Orbital operation. *Norsk Magazin for Loegevidenshaben*, 1911, p. 416. Zur Behandlung des pulsierenden Exophthalmus *Klin. Monatsbl. v. Augenh.*, 1912, Pt. 1, pp. 88-92.
- Lazarew: Ref. Jahres Ref. in Jahresbericht. Nagel-Michel, 1898.
- McClennan: Pulsating Exophthalmos Due to Aneurism of the Internal Carotid. *J. Am. M. Ass.* 1911, p. 1552.
- Maher, W. O.: Notes on Two Unusual Cases of Pulsating Exophthalmos. *Ophthalmol.*, 1914, vol. x, pp. 407-409.
- Mathewson, G. H.: A Case of Pulsating Exophthalmos. *Ophth. Rec.*, 1913, vol. xxii, pp. 294-296.
- Merrill, C. S.: Unreported Case of Pulsating Exophthalmos, 1909.
- Murray, F. W.: The Treatment of Pulsating Exophthalmos. *ANNALS OF SURG.*, 1904, p. 421.
- Noyes, H. D.: Pulsating Exophthalmus. *Tr. Am. Ophth. Ass.*, 1881, vol. iii, p. 308.
- Orloff: Traitement de l'exophtalmie pulsatile traumatique. *Annals d'Oculistique*, 1911, p. 40.
- Ophthalmoscope, July, 1908.
- Palen, G. J.: A Case of Pulsating Exophthalmos. *J. Ophth., Otol. and Laryngol.*, 1911, vol. xvii, pp. 197-202.
- Pincus, F.: Spontanheilung eines traumatischen pulsierenden Exophthalmus. *Ztschr. f. Augenh.*, 1907, vol. xviii, pp. 33-41.
- Pooley: Arteriovenous Aneurism (Pulsatory Exophthalmos). *Arch. of Ophth.*, 1908, p. 449.
- Ransohoff, J.: Pulsating Exophthalmos; Ligature of the Common Carotid, External Carotid and Superior Thyroid Arteries. *Surg., Gynec. and Obst.*, 1906, Pt. 3, pp. 193-195.
- Reclus: Sur une observation d'exophtalmos pulsatile. *Gaz. des Hopitaux*, 1908, p. 1001.
- Risley: Traumatic Aneurism of Cranial Artery. *Annals of Ophth.*, 1912, p. 375.
- Rubel, E.: Ophthalmoskopischer Befund bei pulsierendem Exophthalmus. *Monatsbl. f. Augenh.*, 1913, n. f., vol. xvi, pp. 62-65.
- Santos Fernandez dez Balbuena: Exoftalmia pulsatil por aneurisma curado con las inyecciones de gelatina. *Revista de Medicina y Cirurgia de la Habana Se Publica los Dias 10 y 25 de Cada Med.*, p. 296, 1907.
- Sattler, H.: Ueber ein neues Verfahren bei der Behandlung des pulsierenden Exophthalmus. *Klin. Monatsbl. f. Augenh.*, 1905, vol. xliii, pp. 1-61.
- Savariaud: Exophthalmos pulsatile. *Bull. et mém. Soc. de Chir. de Par.*, 1912, n. s., vol. xxxviii, p. 672.
- Schaefer, R. J.: Ein Fall von pulsierenden Exophthalmus. *Deut. med. Wochenschr.*, 1910, vol. xxxvi, p. 124.
- Schwalbach, G.: Zur Behandlung des pulsierenden Exophthalmos. *Klin. Monatsbl. f. Augenh.*, 1905, vol. xliii, Pt. 2, pp. 475-479.
- de Schweinitz and Holloway: Pulsating Exophthalmos. *Saunders*, 1908.

- Silvan, C.: Sopra un caso di esofthalgo pulsante guarito in seguito alla legatura della carotide comune. Riv. veneta di sc. med. Venezia, 1914, vol. lxi, pp. 51-64.
- Slomann: Centralb. f. Chirurg., 1900, p. 182.
- Sattler: Handbuch von Graefe-Saemisch, 1880, i, Aufl.
- Siegrist: Graefe's Archiv, 1900.
- Weinkauff, K.: Doppelseitiger idiopathischer Exophthalmus pulsans mit spontaner Ruckbildung. Arch. f. Ophth., 1910, vol. lxxiv, pp. 352-356.
- Wilder, W. H.: Report of Two Cases of Pulsating Exophthalmos. Tr. Am. Ophth. Soc., 1909-1911, vol. xii, pp. 832-841.
- Williams, G.: Pulsating Exophthalmos. Proc. Roy. Soc. Med., Lond., 1910, Pt. 3, Klin. Sect., p. 171.
- Wing: Case of Pulsating Exophthalmos. Tr. Med. Soc., Washington, 1891, p. 123.
- Wurde mann, H. V., and Blacoe, N. M.: Pulsating Exophthalmos. Ann. of Ophth., 1904.
- Wiesinger: Munchen med. Wochenschr., 1903.
- Yvert: Cas remarquable d'exophtalmie pulsatile guerie des instillations d'adrenaline. Gazette des hopitaux de Lyon, 1906-1907, p. 89.
- Zeller, O.: Die chirurgische Behandlung der durch Aneurysma arterio-venosum der Carotis int. im Sin. cavernosus hervorgerufenen pulsierenden Exophthalmus; ein neues Verfahren. Deutsche Ztschr. f. Chir., 1911, vol. cx, pp. 1-39.

OPERATION FOR REMOVING THE GALL-BLADDER *

BY JOHN B. DEEVER, M.D.

OF PHILADELPHIA

SURGEON-IN-CHIEF TO THE GERMAN HOSPITAL

THE type of operation performed in the German Hospital Clinic for the removal of the gall-bladder, and which I believe is as simple as any, enabling one to explore the common duct throughout its entirety with ease and at the same time to control the bleeding from the gall-bladder bed, is the following:

With the abdomen open, the gall-bladder and the right free border of the gastrohepatic omentum freed of adhesions (not that there are adhesions in all cases), this region is thoroughly walled off, when with retractors the assistant keeps the wound wide open. The edge of the liver and the fundus of the gall-bladder are grasped with the left hand carrying a piece of moist gauze, pulled downward, outward and upward, which makes taut the cystic duct and the free border of the gastrohepatic omentum (Fig. 1).

When the liver is adherent to the parietal peritoneum to the degree that it would not be wise to attempt severing the adhesions, it will not be possible to dislocate the liver in the above manner. In the presence of a diverticulum (a dilatation of the gall-bladder at its junction with the cystic duct, sometimes called the pelvis), the diverticulum conceals the upper portion of the gastrohepatic omentum and is frequently adherent to it. In either of the above conditions the cystic duct and the free border of the gastrohepatic omentum, between the layers of which lies the duct, are made prominent by grasping either the gall-bladder low down or the diverticulum with a long pair of curved forceps and making traction (Fig. 2).

Where the diverticulum is adherent to the free border of the gastrohepatic omentum it must be freed before effective traction can be made upon the cystic duct. Unless this be carefully done the common duct may be injured, as occurred in one of the writer's cases. A small incision is made through the upper part of the free border of the gastrohepatic omentum and the cystic duct exposed (Fig. 3). The cystic duct at its junction with the gall-bladder is clamped with a long pair of hæmostatic forceps and cut across distal to the forceps with the

* Read before the College of Physicians, Philadelphia, January 5, 1916.

actual cautery (Fig. 4). A small piece of gauze is placed beneath the border of the gastrohepatic omentum to take up the bile that escapes when the cystic duct is divided (Fig. 5). A small, followed by a larger, probe is passed into the stump of the open cystic duct and carried through the common duct into the duodenum (Fig. 6), in this wise determining whether the duct and the papilla of Vater are patulous. Before the probe is withdrawn from the common duct, the duct is palpated by grasping the descending duodenum and head of the pancreas between the fingers and thumb of the free hand, when it is definitely settled whether the common duct contains a stone or stones. Further, by this means, if the duct contains a stone which is not detected by the probe and yet the probe has passed into the duodenum, through the wall of which the end of the probe can be felt, the stone will be palpated and it can also be determined if there be obstruction outside of the duct. Next, the cystic artery, lying above and to the inner side of the cystic duct, is clamped and cut. In a small percentage of cases the cystic artery lies below and to the outer side of the cystic duct. If it is not necessary to drain the common duct through the stump of the cystic, the cystic duct is ligated and next the cystic artery (Figs. 7 and 8).

The next step is the separation of the gall-bladder from the liver.

This dissection is made from below upward, the gall-bladder is freed and turned upward and outward and the gall-bladder bed closed by carrying a continuous catgut suture through the liver substance forming the sides and floor of the gall-bladder bed (Fig. 9). The free end of the suture is left long and tied to the portion of the suture the needle carries through the liver substance. The tie is made on the upper side of the line of apposition of the walls of the gall-bladder bed. It will be seen that as the gall-bladder is removed step by step the suture is passed and tied so that when the gall-bladder is entirely removed the gall-bladder bed is completely closed; by this means the procedure is made a bloodless one (Fig. 10). I regard this far preferable to packing the gall-bladder bed with gauze or placing a cigarette drain therein and retaining it by suture. In a small percentage of cases where the walls of the gall-bladder are not extensively infiltrated, it will suffice to incise the serosa in the long axis of the organ upon either side sufficiently far from where it is attached to the liver to cover the gall-bladder bed when the edges are apposed by a continuous catgut suture. The lateral flaps of the serosa are reflected and the gall-bladder removed from below upward, leaving enough of the fibrous coat so as not to trespass upon the liver. There are a few instances when a gall-bladder can, to better



FIG. 1 —Liver dislocated, gall bladder exposed

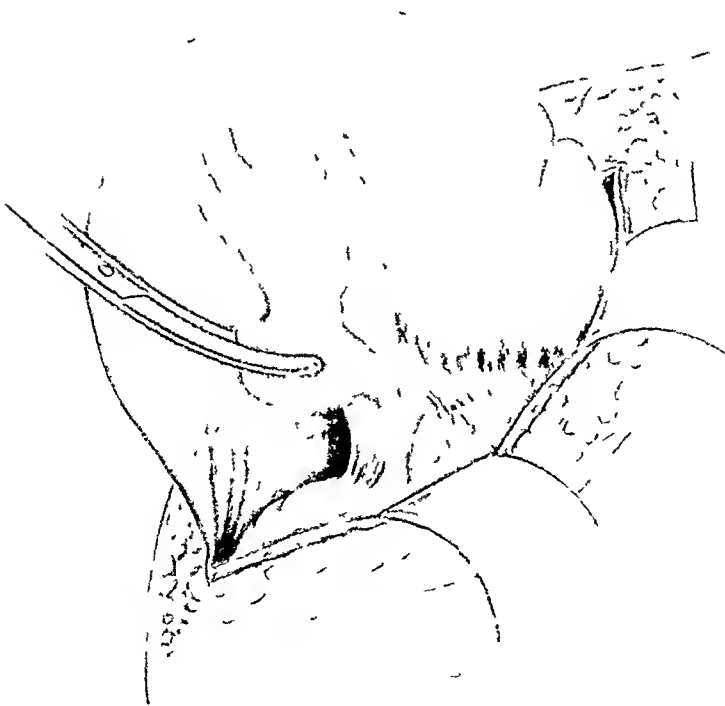


FIG. 2 —Hæmostatic forceps grasping infundibulum of gall-bladder, right free border of gastrohepatic omentum with cystic duct made taut.

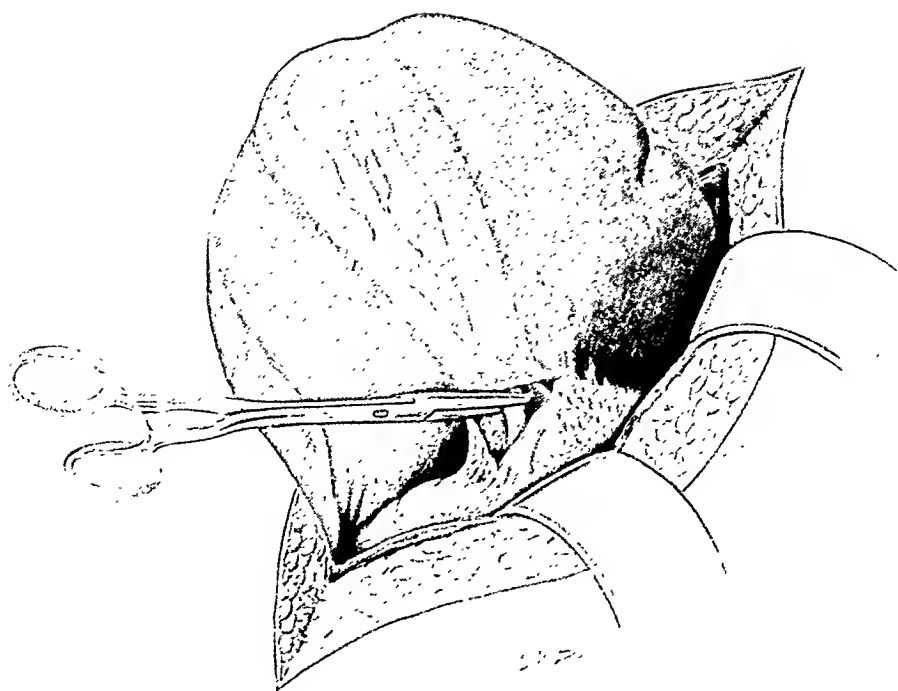


FIG. 3.—Cystic duct exposed, hæmostatic forceps in position.

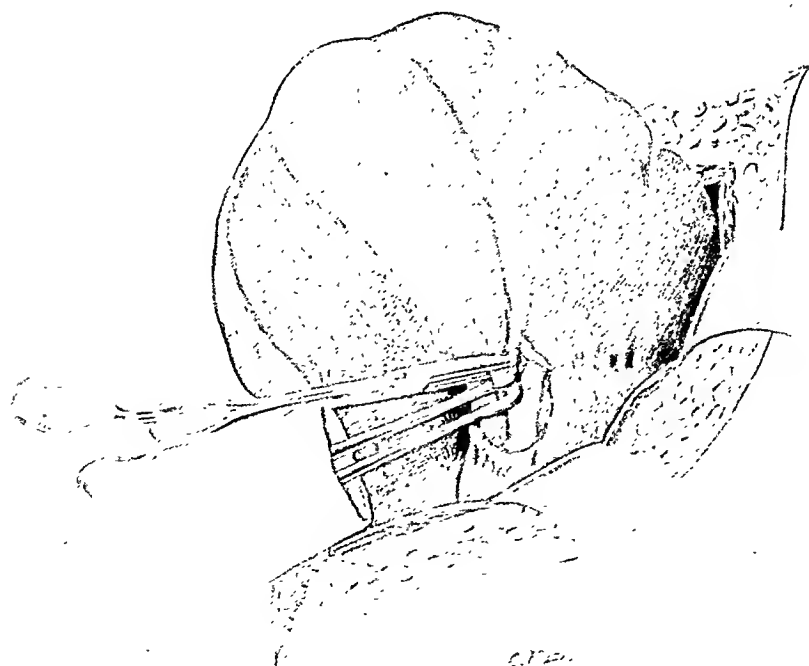


FIG. 4.—Cystic duct divided with cautery.

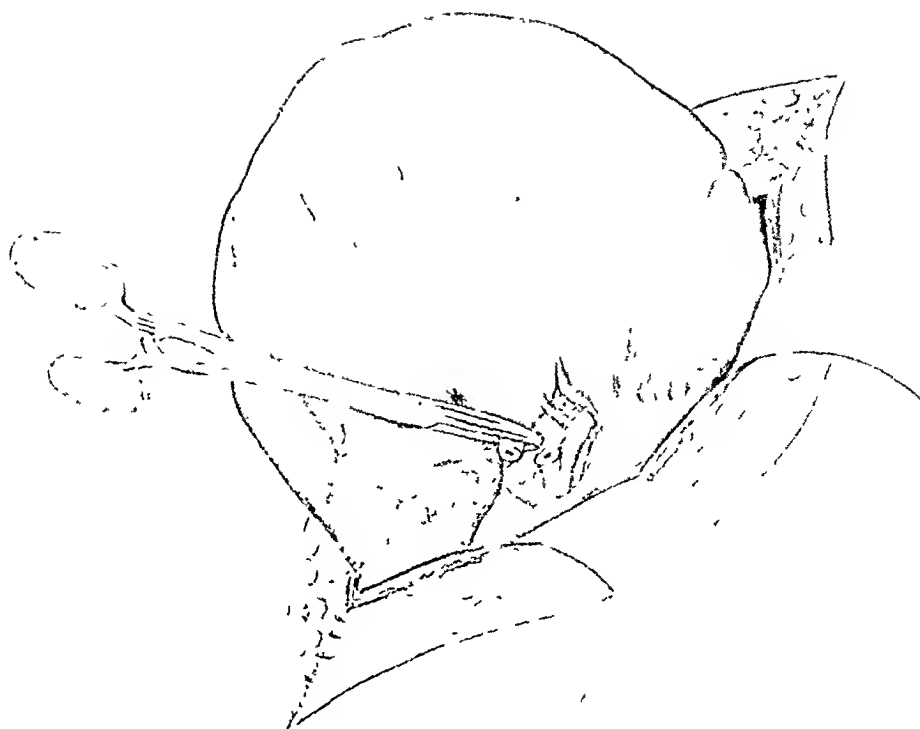


FIG. 5.—Orifice of cystic duct, cystic artery and hepatic duct exposed.

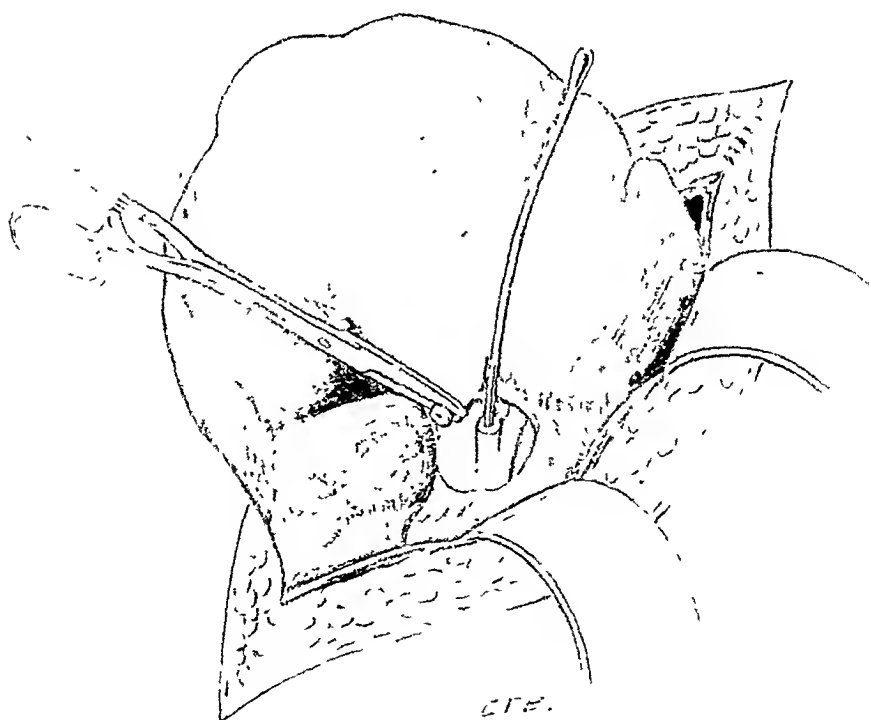


FIG. 6.—Probe introduced into orifice of cystic duct.

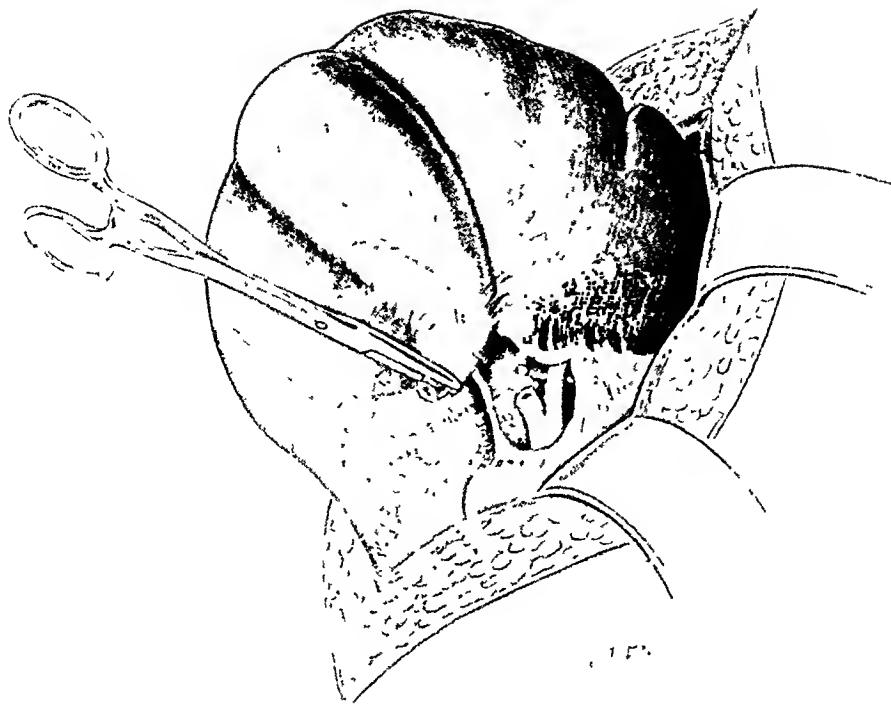


FIG. 7.—Cystic duct divided, hæmostatic forceps upon neck of gall-bladder and orifice of cystic duct exposed.



FIG. 8.—Removal of gall-bladder, cystic duct and artery ligated.

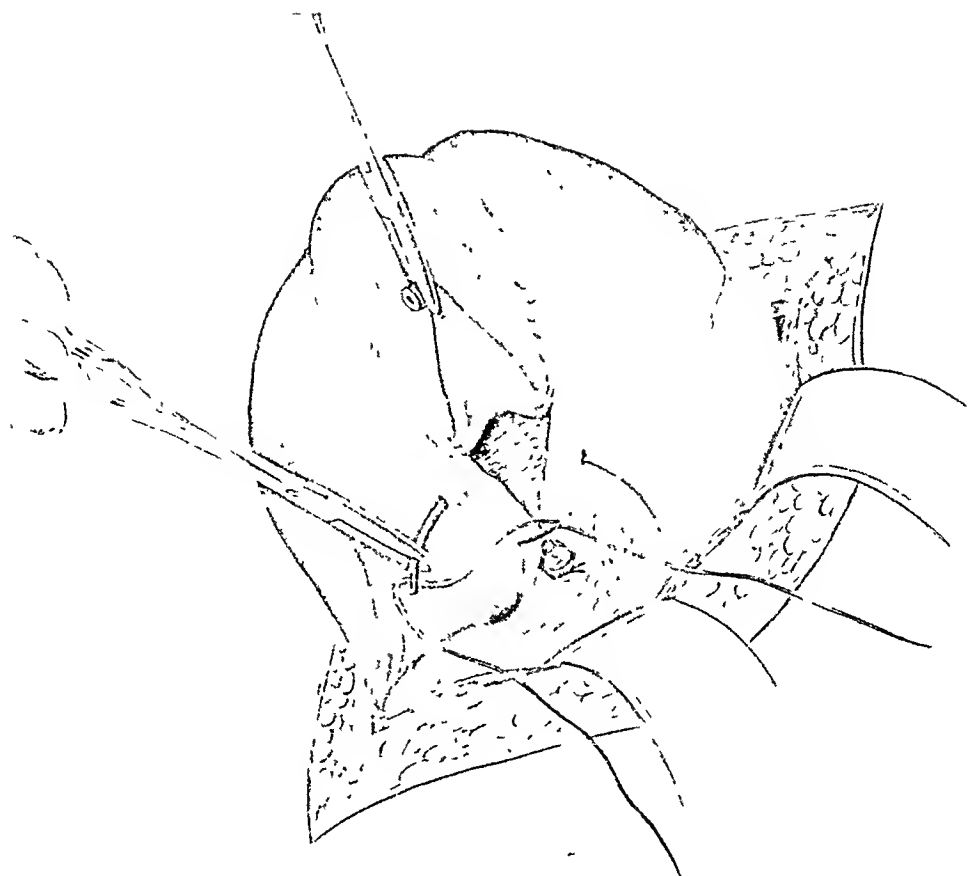


FIG. 9.—Commencing suture of gall-bladder bed.

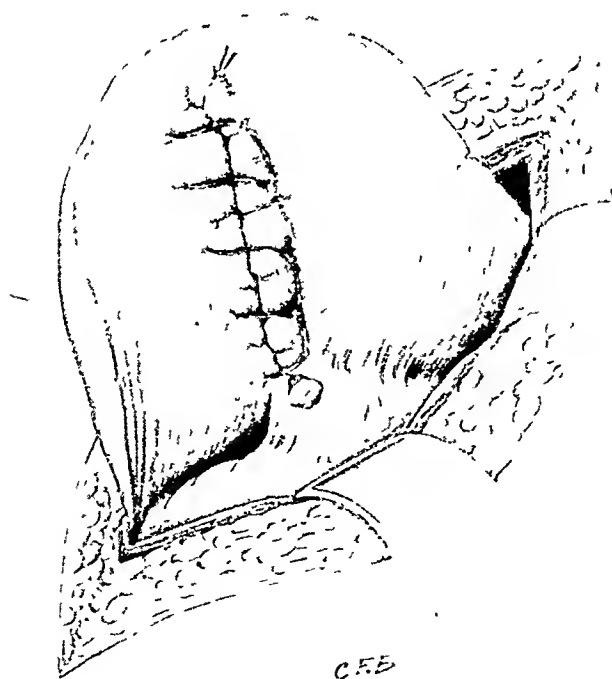


FIG. 10.—Gall-bladder bed sutured.

OPERATION FOR REMOVING THE GALL-BLADDER

advantage and with greater safety, be removed from above downward, commencing the dissection at the fundus.

The next step is suturing the divided layers of the gastrohepatic omentum, but not covering in the stump of the cystic duct. The final step is the placing of a small rubber tube down to and just beyond the free border of the gastrohepatic omentum, which is retained for four or five days, so that in the event of the ligature on the cystic duct giving way the bile will have an exit. Occasionally a glass tube is used, when it is replaced the following day by a rubber tube, the latter being small enough to be carried down the glass tube and the glass tube withdrawn. When the gall-bladder is so large that access to the cystic duct is difficult, it may be aspirated or opened and emptied, care being taken to guard against infecting the field of operation, when the removal, as above described, can be made. In some cases of gangrenous and phlegmonous gall-bladders the operation is made a little more difficult than in ordinary cases, yet this technic can be carried out.

Drainage of the common duct by way of the stump of the cystic duct is only a temporary procedure. When, as is frequently the case, it is necessary to have prolonged drainage of the common duct, I open the common duct and introduce a T-shaped rubber drainage tube. Dr. Riesman and I have one patient who is wearing such a tube now going on three years. I have a number of patients wearing these tubes. This form of drainage is introduced in certain cases of pancreatic lymphangitis, chronic interstitial and interacinar pancreatitis.

In passing, I beg to say that early drainage of the common duct by this method or by a cholecystoduodenostomy is the only chance for the cure of pancreatic diabetes. Metabolic studies will never cure pancreatic diabetes, only the early use of the aseptic scalpel and establishing drainage before the infection has caused a serious pancreatic lymphangitis, a forerunner of chronic pancreatitis, and this in turn of pancreatic diabetes.

ACUTE OPERATIVE DILATATION OF THE STOMACH*

REPORT OF A FATAL CASE AT THE TERMINATION OF GASTRO-ENTEROSTOMY FOR CHRONIC DUODENAL ULCER: FIVE ADDITIONAL CASES OF OPERATIVE DILATATION COLLECTED FROM THE LITERATURE: A SPECIAL STUDY OF THE ETIOLOGY OF ACUTE OPERATIVE AND POST-OPERATIVE GASTRIC DILATATION

BY BURTON J. LEE, M.D.

OF NEW YORK

ASSOCIATE SURGEON, FIRST SURGICAL DIVISION, NEW YORK HOSPITAL

At the December meeting of this Society* the writer reported an unusual and fatal case of acute gastric dilatation, superimposed upon a chronic dilatation of the stomach. The patient died upon the table at the termination of the operation and the author felt that the whole subject of acute operative and post-operative gastrectasis was worthy of more complete study than could be covered in a simple case report.

The general subject of acute dilatation of the stomach has long been recognized as a definite clinical entity. Miller and Humby in 1853 reported a fatal case of unusual distention of the stomach, the autopsy showing contracted small intestines with no evidence of malignant disease. Bennett, in 1856, and Wilks¹ in the following year made reports of cases. Brinton, in 1859, gave a comprehensive description of the disease and included some interesting post-mortem findings. It is evident that he recognized the malady and appreciated its serious aspects. Speaking of dilatation of the stomach, he said: "On the one hand, it is incidental to various gastric maladies; on the other hand, it is occasionally the symptom (or rather the expression) of a mysterious and fatal disease which is chiefly and exclusively concerned with the stomach."

Fagge, in 1873, gave the first adequate discussion of the subject in English. He described the clinical symptoms at length and advised lavage as the only efficient treatment. His work was far-reaching and from that time on reports of similar cases may be found in the literature at frequent intervals. In 1891 Kundrat made a report of three fatal cases of intestinal obstruction, the autopsy showing a very marked dilatation of the stomach and duodenum. He attributed the cause of the distention of the organs to an obstruction of the duodenum. Riedel, in 1892, was one of the first to point out that acute dilatation of the stomach could follow an operative procedure. Schnitzler, in 1895,

* Read before the New York Surgical Society, March 8, 1916.

¹ Quoted by Fagge.

ACUTE OPERATIVE DILATATION OF THE STOMACH

emphasized the mechanical obstruction of the duodenum as a cause of gastric dilatation and suggested the so-called postural treatment to obviate the difficulty. In 1899 Albrecht considered particularly the relationship between arteriomesenteric duodenal occlusion and gastric dilatation.

Thompson later contributed considerable clinical data, and in 1907 Conner made the whole matter the subject of critical study. His article called attention in this country to the condition, and since that time acute dilatation of the stomach has been more frequently recognized. Later contributors have been Laffer, Smith, Chavannaz, Müller and Payer, the last named covering the literature up to the year 1910. The latest papers in English were by Borchgrevink and Ruth, in 1913. In the following year Linke made a critical analysis of the condition.

The entire subject is so extensive that it seems wise to concentrate attention on certain limited phases of it. Diagnosis, treatment and also the general topic of non-surgical acute dilatation will not be considered. This report is a study of one personal case of acute operative dilatation of the stomach and of five similar cases, collected from the literature. In the discussion it is proposed to deal particularly with the pathogenesis of acute operative and post-operative stomach dilatation.

Acute Operative Dilatation of the Stomach.—Smith, in 1909, stated that the earliest recorded case of acute post-operative dilatation developed twenty hours after surgical intervention. Many writers believe, however, that a much shorter interval may elapse between the operation and the appearance of the dilatation. After making a careful examination of the gastric conditions in 300 cases under general anæsthesia, Payer was able to determine a distinct atony and dilatation of the stomach in nearly all the patients immediately after awakening from the narcosis. This paresis subsided, as a rule, in twelve or fourteen days. In cases where it persisted a grave clinical picture of acute dilatation of the stomach developed. Barker, Mathieu and also Ruth have pointed out that acute dilatation of the stomach might occur during operation and prove rapidly fatal.

Mason and Evans reported a case (No. 5) with persistent vomiting, following operation. The symptoms began upon awakening from the anæsthesia and were continuous with those of acute dilatation. Rhodes was evidently so impressed with the early onset of symptoms of acute dilatation in operative cases, that he advised lavage in every patient, either upon the operating table or immediately upon their return to the ward. Hendon states definitely that in many cases certain symptoms may be present for twenty-four hours before the vomiting of acute dilatation ap-

pears. These facts suggest that many instances of acute gastric dilatation reported as occurring during the early post-operative days are cases which have been suffering from mild progressive symptoms from the time of operation or from a period shortly following it. Attention is especially called, therefore, to the possibilities of an acute dilatation of the stomach occurring during operation, with the submission of the following six cases.

CASE I.—*Acute operative dilatation of the stomach following perineorrhaphy.* Reported by E. L. Moorehead, 1909. Mrs. Q., aged twenty-two years. Perineorrhaphy, double salpingo-oöphorectomy and appendectomy performed under ether anæsthesia, preceded by hypodermic injection of morphine sulphate gr. $\frac{1}{4}$ and atropine sulphate gr. $\frac{1}{120}$. As the perineorrhaphy was finished, a swelling suddenly appeared within the abdomen, extending downward to the midpoint between the umbilicus and pubis. The pulse and respiration were unchanged. Laparotomy was then performed and a dilatation of the stomach was found. A stomach tube was inserted through the œsophagus and there was a gradual subsidence of the swelling with a discharge of considerable odorless gas. By lavage the water returned practically clear. The abdominal portion of the operation was then completed. Following the operation there were symptoms of gastric dilatation for about two days. The patient recovered.

CASE II.—*Acute operative dilatation of the stomach during suture of a perforating duodenal ulcer.* Reported by W. G. Richardson, 1913. Male, aged forty-seven years. Perforation of a chronic duodenal ulcer, situated about one-half inch from the pylorus. Operation was performed seven hours after perforation. The stomach was empty and a small duodenal perforation readily found. The operation was uncomplicated and the ulcer was closed with the usual purse-string suture. The anæsthesia was a difficult one, for the man was an alcoholic. Chloroform was at first administered and following this ether, the open method being used throughout the operation. The man's color was poor during the entire anæsthesia and his breathing abnormal. Most of the time his pupils were widely dilated. During the suturing of the wound, there was a rapid distention of the stomach and its veins were considerably engorged. No dilatation of the duodenum was noted and there was no distention of the lower abdomen. A stomach tube was passed and a quantity of gas, under tension, was evacuated. The stomach rapidly contracted and the operation was then completed, the patient making a normal recovery.

CASE III.—*Acute operative dilatation of the stomach associated with double salpingectomy.* Reported by A. Mayoral, 1915. Female, aged twenty-one years, double suppurative salpingitis. Dilatation and curettage performed; patient then placed in the Trendelenburg position and a median laparotomy was done. Both tubes were the seat of an inflammatory process and there was a certain amount of pelvic inflammation. The operator had removed the right tube, and as he was about to amputate the left, "the patient began to act queerly, the respiration quickened, the pulse became rapid and thready and the intestines came out of the wound and were held back with difficulty. I continued the operation as well as I could, and in placing my hand in the wound was surprised to find the stomach at the upper edge of the incision, and a second later almost

ACUTE OPERATIVE DILATATION OF THE STOMACH

three fingers' breadths from the symphysis pubis." A stomach tube allowed the escape of a good quantity of gas, but there was no exit of fluid. The anæsthesia was a difficult one and deeper narcosis was frequently asked for, the patient being rigid throughout the operation. Complete relaxation was obtained only a short time before the appearance of the dilated stomach. The patient's recovery was uneventful.

CASES IV AND V.—*Acute operative dilatation of the stomach, associated respectively with appendectomy and posterior gastro-enterostomy for gastric ulcer.* Reported by W. H. Lockett, 1915. In each instance the dilatation of the stomach was definitely visible and the operator was able to verify by palpation the rapid distention of the organ. In neither case had the patient been under anæsthesia longer than fifteen minutes when the dilatation occurred. The stomach tube was passed in both cases, the upper end being immersed in water. There was an escape of gas, but no fluid material, with rapid relief of the symptoms. The surgeon believed that the dilatation in both instances was due to a swallowing of air during the operation, and thought that he had observed this swallowing act before the gastric distention occurred.

CASE VI.—*Acute operative dilatation of the stomach, superimposed upon chronic dilatation with pyloric stenosis. Perforating ulcer of the duodenum; posterior gastro-enterostomy; death upon the operating table; autopsy.* Male, aged 31 years; a longshoreman; Peruvian. Family and personal history negative. Had syphilis ten years before admission, but received little treatment. No history of cough, but recently he developed night-sweats. Never any dyspepsia or loss of appetite. Five years before admission he began to suffer from slight pain in his epigastrium, when his stomach was empty. No vomiting was present nor any other symptom save the pain, which continued for about two years. No previous operation. Seven months before admission he had a severe attack of pain in the abdomen and soon felt very sick. He had a large hemorrhage from the bowels and fainted a moment later. There was no vomiting, but for several days blood continued in the fæces. About a month before admission he began to have epigastric pain, coming on two or three hours after meals, which was relieved by eructation of gas. For the three days prior to entering the hospital, vomiting was frequent. The vomitus included food taken thirty hours before, and some black material, but no blood. He had lost sixty-seven pounds in the last seven months.

Physical Examination.—Some loss of flesh and moderate anæmia. Mouth, teeth and pharynx negative; tongue slightly coated. Moderate general enlargement of lymph-nodes. Chest normal save for slight changes in percussion note. Heart and arteries normal. The abdomen was soft and tympanitic, but there was no tenderness, rigidity or masses. The liver percussed nor-

mal. Further examination showed nothing of any importance.

Laboratory Examinations.—The string test for blood in the duodenum was positive. The report on the fasting contents of the stomach showed 170 c.c. of dark brown viscid fluid, one-half being food remnants; no mucus; guaiac, ++; free HCl, 37; total acidity, 67; combined acidity, 24; microscopic examination, no red blood-cells. Ewald test-meal showed: 170 c.c. of dark brown fluid, with one-quarter food remnants; mucus, slight amount; guaiac, +; free HCl, 33; total HCl, 66; combined HCl, 26; microscopic examination, food remnants, but no red blood-cells. Blood in stools positive by guaiac test. Urine was negative and the daily amount was 1000 to 1600 c.c.

Radiographic Examination (by Dr. Busby).—"A suspicion of carcinoma about the pylorus and some gastroptosis. The six and twenty-four hour meals show considerable retention."

Diagnosis.—Duodenal ulcer with pyloroplasm, neoplasm not excluded.

Operation.—Anæsthesia—gas and ether. Posterior no-loop gastro-enterostomy. A six-inch midline incision above the umbilicus; the pylorus just admitting the tip of the finger. Lying behind and below the pylorus, adjacent to the first part of the duodenum, was an indurated mass about two inches in diameter, believed to be an ulcer. Excision seemed so difficult that a no-loop posterior gastro-enterostomy was done. The gastrocolic omentum was tacked up to the stomach in the usual way. As the closure of the abdomen was begun, the intestines began to be pushed out through the abdominal wound, suggesting that the patient was coming out of the anæsthesia. More ether was requested by the surgeon. Because of this bulging of a portion of the abdominal viscera, the closing of the peritoneum was attended with some difficulty. No suspicion was entertained at this moment that an acute dilatation of the stomach was the cause of the intestinal protrusion and time was taken to close the abdomen with tier sutures. As the final skin stitches were being placed, it became apparent that the patient was in a desperate condition, and he was dead a moment later. Artificial respiration was performed for ten minutes and an effort was made to massage the heart through the abdominal wound, which had been hastily reopened. Time of operation, one hour and thirty minutes.

Autopsy (by W. Elser).—Examination made 48 hours after death.

Summary.—*Diagnosis:* Stenosis of pyloric orifice; chronic dilatation of stomach with acute dilatation superimposed; ulcer of duodenum (perforating); œdema of the lungs; chronic pulmonary tuberculosis.

ACUTE OPERATIVE DILATATION OF THE STOMACH

The positive findings follow: Rather anæmic subject. Abdomen distended and rather tense. *Heart*: A trifle smaller than normal; weight, 9 ounces. *Aorta*: The entire vessel was relatively small, considering the size of the individual. *Coronaries*: Smaller than usual. *Pleuræ and Lungs*: High grade of pulmonary œdema and congestion of right lung, especially at base; similar, but less marked, findings in left lung. Firm pleural adhesions at both apices, with numerous tuberculous foci at left apex. "*Stomach* is enormously dilated and partially filled with a grey, thin fluid material and gas. When moderately distended with water the stomach measures 17 inches by 10 inches by 7 inches.² On the posterior aspect of the stomach, about 4 inches from the pylorus, an anastomosis between the stomach and the jejunum has been made. The duodenum is markedly dilated. The marked distention of the duodenum comes to a sudden stop at the point where the mesentery crosses the gut.³

"Dissection of the stomach and duodenum in the hardened state reveals the following somewhat remarkable conditions. The pyloric orifice viewed from the stomach side appears as an opening irregularly circular in outline and measuring a trifle less than 5 mm. across. The lip of this opening consists of puckered, greyish-yellow mucous membrane. Viewed from the duodenal side an irregularly circular opening measuring 7 by 10 mm. is found. The lower part of the margin is denuded of mucous membrane. Situated below and between these openings, which evidently represent the terminals of the pyloric channel, is a cavity about the size of a pigeon's egg, presenting an irregular surface. A probe passed through what appears to be the pyloric channel traverses the upper end of this cavity; in other words, the floor of the pyloric channel is wanting. The cavity proper extends beneath the greater curvature of the stomach, encroaching upon the pancreas. It does not extend, however, to the duodenum itself. Between the inner surface of the cavity facing the duodenum and the duodenum proper, a triangular portion of the pancreas, measuring at its base 2 cm., is interposed."

Microscopical examination of the walls of the duodenal ulcer showed the usual picture of a benign ulcer of long standing. A microscopical examination of the stomach wall showed marked

² See photograph of the organ *in situ*, and of the organ in the hardened condition.

³ The stomach, duodenum and a portion of the jejunum were filled with formaldehyde and preserved for museum purposes.

thinning of the mucosa and musculature, due to distention of the organ.

Remainder of small intestine moderately distended with fluid material; mucosa œdematous. Large intestine, particularly the transverse colon, distended with gas; mucosa œdematous. Mesenteric lymph-nodes moderately swollen.

"The marked dilatation of the stomach, including the duodenum, and the close similarity of the findings in this case with those noted in other uncomplicated cases of acute dilatation of the stomach, leaves, in our opinion, little doubt concerning the correctness of the diagnosis in this case. Concerning the exact cause of death, absolute certainty is not attainable."

From a consideration of the preceding data, it is apparent that acute operative dilatation of the stomach is not of infrequent occurrence. Case VI contains, however, some factors of uncertainty as to the propriety of including it with the other examples of acute operative dilatation, and demands special attention. Concerning the degree of chronic dilatation existing prior to operation, the X-ray pictures show a large stomach, and the partial obstruction of the pylorus offers an explanation of this condition. Moreover, the pictures do not reveal an organ at all comparable in size with the one found at autopsy. Furthermore, observation during the operation did not indicate that the stomach was of such size as was found by the pathologist. Finally, the protrusion of intestinal coils, near the end of the operation, was an unusual occurrence calling for comment at that time. It is reasonable, therefore, to regard this case as an acute operative dilatation.

At this point it seems proper to consider the factors which may have determined this man's death. Aside from the possible influence of a rather prolonged anæsthesia, producing, or helping to produce, the acute dilatation of the stomach, the general toxicity of the anæsthesia must also be borne in mind. A second element to be considered is the hypoplasia of the vascular system, which certainly may have had some relation to the man's vulnerability. Without other evidences of status lymphaticus, it seems justifiable to decide that this condition of hypoplasia was not a factor in the fatal termination. Pulmonary and coronary embolism were excluded at autopsy. Œdema of the lungs may not be dismissed. The absolute cause of death cannot be determined with certainty, but the clinical and pathological observations lead to the conviction that the acute dilatation of the stomach was an important factor.

Numerous theories have been advanced to explain the pathogenesis of acute dilatation of the stomach. Many writers suggest that indi-

ACUTE OPERATIVE DILATATION OF THE STOMACH

vidual predisposition may have some influence. In support of this theory, Payer, Chavannaz, Pignacca and Linke cite instances of acute dilatation of the stomach in successive operations upon the same patient. Individual predisposition is so indefinite that it seems impossible to discuss it intelligently. A differentiation should be made, however, between so-called predisposition and certain predisposing factors, which may be regarded as favoring the development of acute dilatation. Such conditions as gastropstosis, enteropstosis, hyperchlorhydria, and various forms of digestive and nervous disturbances have been occasionally assigned as predisposing causes.

Riedel's theory of serous infiltration of the stomach wall, with subsequent dilatation, is not confirmed by other observers. Arcangeli's⁴ hypothesis attributes the gastric dilatation to secretory insufficiency of the adrenal glands, and Kuru believes that lesions of the chromaffin system occasionally play an important part in the paresis of the stomach.

On the other hand, Albrecht, Müller, Nicholls, von Haberer and others support the belief that arteriomesenteric occlusion of the duodenum is the primary factor in the acute dilatation of the stomach. Albrecht showed that normally, at the mesenteric crossing of the duodenum, there is a slight physiological obstruction to the passage of duodenal contents. It is well known that in the normal duodenum there is a groove upon the anterior surface, where it is crossed by the superior mesenteric vessels. Conner found that duodenal obstruction by the mesentery was probably present in from one-half to one-third of all cases of acute gastric dilatation. He concluded that the pull downward upon the mesentery, by the empty small intestines hanging in the true pelvis, could produce obstruction at the lower end of the duodenum. Albrecht's experiments on the cadaver demonstrated that a weight of two kilogrammes pulling upon the mesentery was sufficient to occlude the duodenum. Pignacca and Hunter claim, however, that the mesenteric traction from this source is never more than one-half kilogramme, and therefore the weight of the intestine alone is insufficient.

Müller called attention to the similarity of symptoms in cases of high intestinal obstruction and acute gastric dilatation. He therefore inferred that the cause of the acute distention of the stomach was an arteriomesenteric obstruction of the duodenum.

The good effect of postural treatment, suggested by Schnitzler, is often advanced as an argument for primary duodenal obstruction. The relief obtained is significant only when the treatment is applied early,

⁴ Quoted by Pignacca.

for then sufficient time has not elapsed to permit a stomach acutely dilated to produce secondarily a duodenal occlusion. On the other hand, most of the cases showing the good results of postural change are those with fully developed symptoms.

There is much evidence which does not favor the theory of primary occlusion of the duodenum. A chronic dilatation of the stomach may be a predisposing cause of duodenal obstruction, either through pressure upon the duodenum or forcing intestinal contents downward, with a drag upon the mesentery. On the other hand, it is apparent that an atonic, dilated stomach favors the development of acute dilatation from the weakened condition of the gastric wall. The presence of a gastro-enterostomy in a case of chronic dilatation with subsequent acute distention seems to dispose of duodenal occlusion as a primary causative factor in these cases and a very considerable number of such instances is cited.

Psaltoff's case, with many others, illustrates the not infrequent finding of the enlarged stomach without any dilatation of the duodenum or evidence of obstruction anywhere throughout the duodenum. Surely in these cases there is no question whatever concerning the non-existence of any primary occlusion of the duodenum, but it is certain that the distention of the stomach is the initial lesion.

Hunter and also Thomson argue against primary duodenal occlusion in cases of acute gastric dilatation in which the intestines are often dilated below the duodenum and therefore below the point for arterio-mesenteric duodenal obstruction. It is apparent here that an occlusion of the duodenum at the mesenteric crossing cannot account for all the dilated intestine found.

The good results obtained in the vast number of cases of acute gastric dilatation by repeated lavage is difficult to explain if the obstruction of the duodenum by the mesentery is really the initial factor. It is difficult to believe that lavage could do any great amount of good to an obstructed duodenum save secondarily, by diminishing the size of the stomach.

In Cases I to V, of this report, the operators actually saw the stomach dilating and, in two instances, the patients had been under the anæsthetic but fifteen minutes. One cannot imagine a mesenteric occlusion acting thus rapidly, and it is necessary to believe that the initial lesion was beginning before the eyes of the operator. It seems fair to grant, therefore, that the primary change in acute gastric dilatation does not lie in an obstruction of the duodenum, but takes place in the stomach itself.

The increasing number of those who believe that the stomach is the

ACUTE OPERATIVE DILATATION OF THE STOMACH

primary lesion, includes: Box and Wallace, Braun and Seidel, Birnbaum, Conner, Laffer, Thomâ, Barker, Mathieu, Ruth, von Herff, and most of the recent writers. All factors entering into the dilatation may be included if we consider the orifices of the distended organ, its muscular wall and influences affecting its tonicity, and finally the gastric contents. Cannon's monograph, "The Mechanical Factors of Digestion," furnishes much valuable data upon the physiological side of the question.

The Cardiac Orifice.—It has been established that most of the time the cardia is closed. This may be demonstrated clinically by inspection and palpation through the opened stomach and by radiographic studies. The nervous impulse controlling the contraction of the cardiac orifice passes along the pneumogastric nerves, and both stimulating and inhibitory fibres are present. Adrenalin, however, which acts upon the sympathetic nervous mechanism, relaxes the cardiac orifice, proving a partial sympathetic control of the cardia.

Cannon has shown that the cardiac sphincter in normal individuals is not always closed. During the presence of food in the stomach there is a rhythmic contraction of the sphincter, with recurring regurgitations of food back into the œsophagus. The positive factors in this regurgitation are gastric contents sufficiently fluid, and a proper amount of pressure within the stomach. After a time the acid in the stomach automatically stimulates cardiac contraction, thus preventing further regurgitation. There is an experimental proof that this same influence of acid upon cardiac contraction persists in animals whose splanchnic nerves have been divided, or whose pneumogastric nerves have been severed, and also in those under anæsthesia.

One element, emphasized by Cannon, may have a bearing upon the problem of dilatation. "Although the evidence points to the acid control of the cardia, through a local reflex, we must not forget that the cardia is nevertheless under the influence of extrinsic nerves, and that in abnormal states, these nerves may cause the sphincter to relax and permit regurgitation of food that is acid."

Kelling felt that both orifices must be closed to permit the development of an acute dilatation of the stomach. He experimented on non-anæsthetized animals with a cannula inserted through the anterior gastric wall. As the intragastric pressure was increased, the animal would vomit, and it was impossible to produce an acute dilatation. On the contrary, when the animal was fully narcotized, or if the pneumogastric nerves were cut, the stomach could be distended until it burst. Braun

and Seidel agreed concerning the valvular action at the cardia. They concluded, however, that the cardiac obstruction obtained by Kelling was probably due to the work having been done through an open abdomen. In their experiments, they found that gas would regurgitate into the œsophagus when the belly was closed. Conner, after reproducing some of Kelling's experimental work, with some variation in results, emphasized that experiments upon the cadaver could not properly be used in explaining the mechanism of acute gastric dilatation.

In cases of paralytic ileus an isolated distended loop of bowel has often been found with no mechanical obstruction above or below, and a similar finding may be obtained in a narcotized animal after traumatism to the intestine. There may be some factors of analogy in the results of such an experiment and the rapid dilatation of the stomach itself in an acute dilatation, though the element of traumatism may be lacking. Smith suggests that an obstruction from paresis might reasonably explain a moderate dilatation of the stomach, without a closed cardia. A very distended organ, on the other hand, would seem impossible without a closure at the cardiac valve.

Knowledge is still incomplete concerning the part borne by acid gastric contents and the extrinsic nervous supply in maintaining the closed cardia in cases of dilatation.

The Pylorus.—It is now clearly understood that the two portions of the stomach are distinct as concerns their functions. The cardiac segment receives the food and serves as a cavity in which salivary digestion is continued. The pyloric portion, however, provides a place for an active gastric digestion. Cannon has established that the pylorus is occluded by contraction when food enters the stomach, this condition persisting for some time. At short intervals the sphincter relaxes, and small amounts of food are discharged into the duodenum. This giving way of the muscular contraction at the pyloric valve is caused by the presence of acid at the pylorus. The acid in the duodenum below the sphincter closes it and it remains closed until the flow of pancreatic and other juices neutralizes the acid. As the process of neutralization progresses, the tonicity of the pylorus is weakened and acid again accumulates on the stomach side of the valve, causing once more a relaxation. Cannon regards the "acid control of the pylorus" as "one of the remarkable automatisms of the body."

Howell has demonstrated that when the splanchnics are stimulated, the contracted stomach dilates and the pyloric sphincter relaxes. It is known that the pyloric valve, as well as the other portions of the muscular wall, receives motor fibres from the vagus nerves. Some

ACUTE OPERATIVE DILATATION OF THE STOMACH

observers have noted contraction, others relaxation of the pyloric sphincter from stimulation of the pneumogastric. Openchowski⁵ was able to cause dilatation of the cardiac opening, and a simultaneous contraction at the pylorus.

Thomson felt that pyloric closure could be put out of consideration, because frequently the duodenum is dilated also, and because the vomitus contains bile. However, a dilated duodenum is absent in many cases of acute gastric dilatation. Moreover, both the distended duodenum and the vomiting of bile may be the result of a secondary duodenal obstruction by the mesentery from the presence of a markedly dilated stomach. It appears probable, however, that, as with the cardia, a contracted pyloric sphincter is an essential element in the production of acute gastric distention. The part played by the acid control of the pylorus and by the extrinsic nervous regulation remains still undetermined.

The Gastric Musculature and Its Nervous Control.—Howell and Cannon regard the motor mechanism of the stomach as an automatic one, but subject to control by the vagus and sympathetic nerves. The stimuli to contraction are intrinsic, while the regulation is extrinsic. The extrinsic nerves are the pneumogastric and the splanchnic, the former being mostly motor, and the latter largely inhibitory. Various plexuses connected with the splanchnics are described, but no practical use has yet been made of their anatomical distribution.

The intrinsic nervous supply of the stomach resides in the plexuses of Meissner and Auerbach, comprising numerous ganglia. In a stomach removed from the body, certain peristaltic movements and some gastric digestion continue for a considerable time, if the organ be kept moist and warm. It is uncertain whether this automatic property resides within the plexuses named or in the muscle itself. Starling has shown that stimulation of the sympathetic diminishes motor activity, through a contraction of the blood-vessels supplying the viscus.

Cannon states that in the presence of unusual mental emotion or fright, gastric peristalsis ceases almost immediately. Experimentally,⁶ acute dilatation of the stomach may readily be produced. When the proximal end of the pneumogastric nerve is stimulated, a reflex inhibition of the normal tone of the stomach occurs and dilatation results. The swift onset of symptoms in numerous dilatation cases suggests a rapid and profound change in the nervous mechanism of the stomach. It seems as if some shock had suddenly reached the organ, paralyzing

⁵ Quoted by Cannon.

⁶ Wertheimer, quoted by Howell.

its functions. A central nervous change appears more probable than one in the intrinsic supply of the organ, for dilatation occurs frequently in the presence of marked toxic symptoms.

There is a great deal of evidence pointing toward some toxic agent, influencing the nervous mechanism of the stomach, resulting in its motor paralysis, and possibly, in an overactivity of its secretory function. Further, the frequent occurrence of marked diminution, or even suppression, of urine in acute dilatation suggests the presence of some toxic substance. Acute gastric dilatation may also occur in the course of pneumonia, typhoid fever, eclampsia and other markedly toxic conditions, and a similar toxæmia may possibly be inferred in the post-operative cases. Hendon calls attention to the marked mental disturbances accompanying acute dilatation, again suggesting some toxic agent. No consideration of toxæmia in acute gastric distention would be complete without thinking of the anæsthetic itself as a possible toxic agent. Most of the acute dilatations develop with or after general anæsthesia. Whatever other toxic substances may be present, the anæsthetic itself must be regarded as a possible added factor contributing to toxæmia.

Gastric Contents.—The normal acidity of gastric juice as it is secreted is about 0.5 per cent. HCl. Boldryeff, in his contribution to the chemistry of the stomach, points out that the maintenance of the gastric acidity at a fixed level is largely accomplished by access of alkaline juices to the organ. An automatic regurgitation from the duodenum permits access to the stomach of pancreatic juice and bile. The former is the most active neutralizing agent, being the strongest alkaline secretion in the body. The latter is normally present in the stomach fluid. Other alkaline juices present are the saliva and the gastric mucus. The process of neutralization continues until the acidity of the stomach is reduced to the usual level of about 0.15 per cent. HCl.

Howell shows that the gastric secretion may be either nervous or chemical. Stimulation of the vagus causes a flow of gastric juice and a coincident pyloric contraction, illustrating the coördination of the motor and secretory functions of the stomach. The pneumogastric also carries some inhibitory fibres. Chemical secretion is induced by secretagogues or hormones from the food or digestive products. The sources of fluid in the stomach are therefore gastric secretion, regurgitation from the duodenum and food and saliva swallowed.

Little data may be found on the character of the fluid contents of the acutely dilated stomach. Unfortunately, in the author's personal case, no analysis of the fluid material was made, that the specimen might be

ACUTE OPERATIVE DILATATION OF THE STOMACH

preserved for gross pathological purposes. Conner, however, says: "There can be no doubt that bile is present in the vomitus in most cases. In several instances, small quantities of blood could be detected in the stomach contents." In some cases, free HCl has been absent, with or without lactic acid. In an instance quoted by Conner there was a total acidity of 48, with free HCl, but no lactic acid. Mathieu proved by chemical analysis that the dark color of the fluid vomited is due to bile, thus proving definitely, in his cases, a regurgitation from the duodenum. The secretion at times is excessive, especially in the more advanced cases. Cases I to V, in this report, illustrate the absence of secretion in the initial stages of the dilatation. Friedmann explains the tremendous secretion on the basis of a stasis in the vessels of the stomach. This theory seems a reasonable surmise, but it is not a proven fact. Pilcher points out the toxicity of the fluid in the stomach and duodenum in cases with acute dilatation. Instances have been reported with a rapidly fatal result, after active catharsis. More clinical data are needed to make a satisfactory decision upon the character of the fluid within the stomach and the source from which it is derived.

It is well known that a certain amount of gas is normally present in the stomach. This gas is regurgitated when the intragastric pressure reaches a definite point, the cardia readily relaxing. The horizontal posture makes eructation of gas more difficult and may interfere considerably with peristalsis. Deep narcosis prevents the giving way of the contracted cardia, as Kelling's experiments seemed to demonstrate. The presence of gas in an acutely dilated stomach may be accounted for either by fermentation of food material in the organ, regurgitation of gas from the duodenum, swallowing of ether or excreting it into the stomach, or by air swallowing. That fermentation of food within the stomach may be a factor in gas production seems improbable, save in the cases of chronic dilatation of the stomach, especially those with some pyloric or other obstruction. On the other hand, the personal case reported possibly illustrates the exceptional example of a chronic dilatation with stenosis where fermentation of material within the stomach might have served as a partial source of gas.

The writer is unable to furnish any definite data concerning a possible regurgitation of gas from the duodenum as a cause for the distention, but believes it very improbable in the early stages of the malady.

That the source of the gas is from the excretion of the anæsthetic through the stomach mucosa seems an unreasonable explanation. The amount of anæsthetic excreted in this way could hardly be sufficient to account for some of the very rapid cases, as instance, one of this series

with acute distention of the stomach fifteen minutes after the beginning of anæsthesia. The suggestion by Gerster that the distention of the stomach may be explained by the swallowing, during anæsthesia, of a small quantity of ether, which may have vaporized within the stomach, is not borne out by clinical or other findings.

Lardennois, Mathieu, Lagarde and Buchholz have laid emphasis on aërophagia as the most important etiological cause of acute gastric dilatation. Couto goes so far as to give physical signs of an habitual aërophagic, that better recognition of the condition may be made. Tissier believes that air swallowing is practically the sole cause of the dilatation, and claims that the symptoms of acute gastrectasis correspond closely to grave cases of aërophagia. Furthermore, the same treatment is effective in both conditions. The anæsthetic, exciting the buccal glands to secrete, causes many patients to swallow at frequent intervals, carrying air with the mucus into the stomach. Several operators have observed air swallowing during the operation. The swallowing is thought to be most marked in those who are confirmed aërophagics. Smith and Le Wald have recently reported some interesting findings in infants by radiographic examination. In the prone position, fluid contents covered both orifices of the stomach, locking the gas within and giving rise to gastric distention and digestive disturbances. It seems certain that rapid dilatation must be associated with the presence of a gas as the distending force, and Cases I to V, seen at the beginning of the malady, confirm this conclusion. Surely the simplest source for the gas is air swallowing, and many proofs lacking for other theories, the writer is compelled to believe that air swallowing is a definite factor in the causation of acute operative and post-operative dilatation. Such a condition by no means excludes some additional toxic influence, acting upon the nervous mechanism with consequent paresis of the gastric wall and secretory functions.

CONCLUSIONS

1. Acute operative dilatation of the stomach is a definite clinical entity and its occurrence is not infrequent.
2. It may be observed during operation and may be the cause of immediate death.
3. Many cases of so-called acute post-operative dilatation have really begun upon the operating table or shortly after the termination of the operation.
4. The dilatation of the stomach is primary.
5. The complete etiological factors are not yet evident.

ACUTE OPERATIVE DILATATION OF THE STOMACH

6. A simultaneous closure of the cardia and pylorus is essential to the production of an acute dilatation.

7. Such a simultaneous closure can probably not be accounted for by the acid gastric secretion, for while it closes the cardia, it relaxes the pylorus.

8. An interference with the nervous mechanism of the stomach, resulting in contracted orifices and a paretic wall, is a probable factor in many cases.

9. The frequent presence of toxic symptoms suggests a change in the central nervous mechanism.

10. The occurrence of acute operative dilatation with difficult anæsthesias suggests that the anæsthetic may exert an important influence.

11. The distending agent is gas, which appears before any accumulation of fluid.

12. The usual source of the gas is an air swallowing during anæsthesia.

13. In certain cases, the air swallowed may be the initial and major factor, with the dorsal position a secondary influence, preventing easy exit of the gas.

14. In acute dilatation, superimposed upon a chronic dilatation of the stomach, fermentation of food residue may account for the presence of some of the gas.

15. Further study is essential to solve the problems of the exact etiology of this malady. This study must be along lines of experimental physiology and physiological chemistry, rather than those of pathology.

The author desires to express his thanks to Professors Gibson, Conner, Ewing and Elser, to Assistant Professors Murlin and Foster, and also to Dr. Yocum, for many helpful suggestions and criticisms in the preparation of the paper.

BIBLIOGRAPHY

- Albrecht, P. A.: Ueber arterio-mesenterialen Darmverschluss an der duodeno-jejunalgrenze und seine ursachliche Bezielung zur Magenerweiterung. *Archiv. f. path. Anatomie, Virchow's.* Berlin, 1889, clvi, 285-325.
- Axhausen: Zur Frage der akuten postoperativen Magendilatation. *Centralblatt für Chirurgie, Leipzig*, 1909, xxxvi, 159-160.
- Barker, M. R.: Acute Post-operative Dilatation of the Stomach following Gastrojejunostomy. *Surg., Gynæc. and Obst., Chicago*, 1911, xii, 384-388.
- Bastedo, W. A.: Post-operative Gastric Paralysis; Acute Dilatation of the Stomach. *Medical Record, New York*, 1906, lxx, 733-735.
- Bayliss, W. M.: Digestion—Principles of General Physiology. London, 1915, 365-376.

- Bennett, H.: Principles and Practice of Medicine—Respiratory Diseases. 1856, Case CXLIV, 667-672.
- Bernier, J. B.: Contribution à l'étude de la dilatation aigue post-opératoire de l'estomac. Thèse, Paris, 1912, No. 188, 56 p.
- Birnbaum, R.: Acute postoperative Magenlähmung. Monatsschrift f. Geburts. u. Gynaekol., Berlin, 1906, xxiv, 170-181.
- Boldryeff, W.: The Acidity of the Gastric Juice. Quarterly Journal of Experimental Physiology, London, 1915, viii, 1-12.
- Bonachi: Dilatation aigüe post-opératoire de l'estomac. Bull. et Mém. Soc. de Chir. de Bucarest, 1905-1906, viii, 113-115.
- Borchgrevink, O. J.: Acute Dilatation of the Stomach and Its Treatment. Surg., Gynec. and Obst., Chicago, 1913, xvi, 662-693.
- Box, C. R., and Wallace, C. S.: A Case of Acute Dilatation of the Stomach. Trans. Clin. Soc., London, 1898, xxxi, 241-242.
- Box, C. R., and Wallace, C. S.: A Further Contribution on Acute Dilatation of the Stomach, with an Account of Two Additional Cases. The Lancet, London, 1901, 1259-1260.
- Braun: Zur akuten postoperativen Magenaustreibung. Deut. Med. Woch., Leipzig, 1904, xxx, 1553-1554.
- Brinton, W.: The Diseases of the Stomach, London, 1859, 343, 348-353.
- Buchholz, E.: Du rôle de l'aérophagie dans la genèse de la dilatation aigüe post-opératoire de l'estomac. Thèse, Paris, 1912-1913, No. 391, 120 p.
- Cannon, W. B.: The Mechanical Factors of Digestion, London and New York, 1911, 227 p.
- Chavannaz, G.: Dilatation aigüe de l'estomac après gastro-entérostomie. Jour. de Méd. de Bordeaux, 1909, xxxix, 5-7.
- Conner, L. A.: Acute Dilatation of the Stomach and Its Relation to Mesenteric Obstruction of the Duodenum. Am. Jour. Med. Sciences, Phila. and New York, 1907, n. s., cxxxiii, 345-373.
- Couto: Sur le syndrome de l'hypertension gazeuse de l'estomac. Bull. et mém. Soc. méd. d. Hôp. de Par., 1914, iii, s., xxxvii, 522-524.
- Cumston, C. G.: The Treatment of Acute Post-operative Dilatation. International Clinics, Phila. and London, 1914, 24 s., iii, 257-260.
- Dahmann: Akute postoperative Magendilatation. Berlin. klin. Wchnschr., 1913, i, 227-228. Gottschalk: Discussion, 228.
- Delangénère, H.: Dilatation aigüe de l'estomac et occlusion de duodénum après les interventions chirurgicales. Arch. prov. de chir., 1909, Paris, xviii, 421-440.
- Duncan, H. A.: Post-operative Dilatation of the Stomach. New York Med. Jour., 1913, xcvi, 502-503.
- Eppinger, H., and Hess, L. (Translation by Krauss, W. M., and Jelliffe, S. E.): Vagotonia—A Clinical Study in Vegetative Neurology. New York, 1915, Nervous and Mental Diseases Monograph, Series No. 20.
- Fagge, H.: On Acute Dilatation of the Stomach. Guy's Hospital Reports, London, 1873, 3d Series, xviii, 1-22.
- Friedmann, G. A.: Die akute Magendilatation mit einem Versuche der Aufklärung der Aetiologie. Archiv. für Verdauungskrankheiten, Berlin, 1911, xvii, Ergänzungsheft, 151-185.

ACUTE OPERATIVE DILATATION OF THE STOMACH

- Garrett, F. D.: Dilatation of the Stomach. Report of Cases. New Mexico Med. Jour., Las Vegas, 1912, ix, 41-44.
- Gerster, J. C. A.: Post-operative Dilatation of the Stomach. Progressive Medicine, Phila. and New York, 1914, ii, 90-91.
- von Haberer, H.: Der Arteriomesenteriale Duodenalverschluss. Ergebnisse der Chirurgie u. Orthopaedie, Berlin, 1913, v, 467-487.
- Halstead, A. E.: Acute Post-operative Dilatation of the Stomach, with Report of a Case Following Nephropexy. Surg., Gynæc. and Obst., Chicago, 1906, ii, 13-17.
- Hanssen, O.: Ein Beitrag zur Klinik der akuten und subakuten Magen-Dilatation. Nordiskt Med. Archiv., Stockholm, 1910, xliii, Abt. II, Heft 4, 1-45.
- Hendon, G. A.: Post-operative Gastric Dilatation. Trans. South. Surg. and Gynæc. Assoc., Washington, 1912, xxiv, 582-602. Discussion: Morris, R. T., *et al.*, 591-602.
- von Herff, O.: Ueber schwere Darm- und Magenlähnungen, insbesondere nach Operationen. Zeitschrift f. Geburtshilfe u. Gynaekol., Stuttgart, 1901, xlv, 251-308.
- Hogan, E. P.: Post-operative Acute Dilatation of the Stomach. Trans. of Med. Assoc. State of Alabama, Montgomery, 1914, 458-473. Also Trans. South. Surg. and Gynæc. Assoc., 1913, Atlanta, Phila., 1914, xxvi, 301. Discussion: Hendon, G. A., 319-321.
- Howell, W. H.: The Relations of the Nerves to the Movements of the Stomach. A Text-book of Physiology, Philadelphia, London, 1915, 6th Ed., 724-725.
- Hunter, J. B.: Case of Acute Dilatation of the Stomach, following Laparotomy. Boston Med. and Surg. Jour., 1887, cxvii, 361.
- Kelling: Ueber den Mechanismus der akuten Magendilatation. Archiv. f. klin. Chir., Berlin, 1901, lxiv, 393-417.
- Kundrat: Ueber eine seltene Form der inneren Incarceration. Abstract im Wien. med. Woch., Leipzig, 1891, xli, 351-353.
- Kuru, H.: Ueber die akute Magenerweiterung. Mitteilungen a. d. Grenzgeb. d. Med. u. Chir., Jena, 1911, xxiii, 169-189.
- Laffer, W. B.: Acute Dilatation of the Stomach and Arteriomesenteric Ileus. ANN. SURG., New York, 1908, xlvii, 390-416, 532-557.
- Lagarde, R.: La dilatation aigüe de l'estomac envisagée comme entité pathologique. Thèse de Toulouse, 1913, No. 38.
- Lardennois: XXIII Congrès de Chirurgie. Résumé. Bulletin Médical, 1910; Presse Médicale, 1910.
- Leonhardt, W. T.: Ein weiterer Beitrag zur Frage der akuten Magenerweiterung. Inaug. Diss., München, 1910, 21 p.
- Linke, R.: Beitrag für Kenntnis, Kasuistik und Therapie der akuten atonischen Magendilatation. Beitr. zur klin. Chir., Tübing, 1914, xciii, 360-391.
- Luckett, W. H.: Visible Acute Dilatation of the Stomach During Laparotomy. Jour. Am. Med. Assoc., Chicago, 1915, lxiv, 2055-2057.
- Lyle, H. H. M.: Acute Dilatation of the Stomach following a Herniotomy Done Under Local Anæsthesia. New York Med. Jour., 1911, xciv, 932.
- McWilliams, C. A.: Acute Post-operative Dilatation of the Stomach; Report of a Severe Type, with Recovery. Surg., Gynæc. and Obst., Chicago, 1908, vii, 294-298.

- MacEvitt, J. C.: Post-operative Acute Dilatation of the Stomach, New York State Jour. of Med., New York and Brooklyn, 1906, vi, 284-288.
- Mason, W., and Evans, N.: Acute Gastric Dilatation. South. Med. Jour., Nashville, 1914, vii, 806-810.
- Mathieu, A.: La distension aigüe de l'estomac avec occlusion duodénale. Le rôle de l'aérophagie dans sa pathogénie. Archiv. des Malad. de l'Appor. Digest. et de la Nutrit., Paris, 1911, v, 409-424.
- Mayoral, A.: Report of a Case of Acute Dilatation of the Stomach. Jour. Am. Med. Assoc., Chicago, 1915, lxiv, 146.
- Miller and Humby: Enormously Dilated Stomach. Trans. of the Pathological Soc. of London, 1853, iv, 137-139.
- Moorehead, E. L.: Acute Dilatation of Stomach During Anæsthesia. Jour. Am. Med. Assoc., Chicago, 1909, lii, 1996.
- Morris, R. T.: Acute Post-operative Dilatation of the Stomach. Boston Med. and Surg. Jour., 1911, clxiv, 564-565.
- Müller, P.: Ueber acute post-operative Magendilatation. Deut. Zeitschrift. f. Chir., Leipzig, 1900, lvi, 486-511.
- Neck: Die akute Magenerweiterung. Centralblatt für Grenzgeb. der Med. u. Chir., Jena, 1905, viii, 529-534; 561-569; 609-617; 658-666.
- Nicholls, A. G.: Acute Dilatation of the Stomach. Internat. Clin., Philadelphia and London, 1908, 18 Series, iv, 80-105.
- Payer, A.: Die post-narkotische Magenlähmung. Mitteilungen a. d. Grenzgeb. d. Med. Chir., Jena, 1910-1911, xxii, 411-482.
- Petit, G.: Considerations Etiologiques et Pathogéniques—Dilatation aigüe de l'estomac après Trepanation Mastoïdienne. Gazette des Hôpitaux, Paris, 1912, lxxxv, 913-915.
- Pignacca, G.: La dilatazione acuta post-operatoria dello stomaco. Morgagni, Milano, 1914, lvi, Pt. I, 290-299.
- Pilcher, J. T.: Post-operative Dilatation of the Stomach and Its Relief. Year-book of the Pilcher Hospital, Brooklyn, New York, 1911, i, 97-104.
- Price: La Dilatation aigüe de l'estomac. Archives prov. de Chir., Paris, 1913, xxii, 688-692.
- Psaltoff: Un case suraigu de paralysie stomacale post-opératoire. Revue de Chirurgie, i, 1909, 602.
- Rhodes, G. B.: Notes on a Case of Acute Post-operative Dilatation of the Stomach. Am. Jour. of Surg., New York, 1914, xxviii, 235-236.
- Richardson, W. G.: A Case of Acute Dilatation of the Stomach Occurring in the Course of an Operation for Duodenal Ulcer. The British Med. Jour., London, 1913, ii, 1202.
- Riedel: Erfahrungen ueber die Gallen-stein Krankheit mit und ohne Icterus, Berlin, 1892, 129.
- Robson, A. W. M., and Moynihan, B. G. A.: Acute Dilatation of the Stomach. Diseases of the Stomach and Their Surgical Treatment, New York, 1904, 2nd Ed., 389-402.
- Ruth, C. E.: Post-operative Acute Dilatation of the Stomach. Amer. Jour. of Obst., New York, 1913, lxvii, 525-538.
- Schnitzler: Wiener Klinische Rundschau, 1895, ix, 579-581.
- Starling, E. H.: Principles of Human Physiology. Digestion of the Stomach, Philadelphia, 1915, 683.

ACUTE OPERATIVE DILATATION OF THE STOMACH

- Selby: Acute Dilatation of the Stomach. *Amer. Jour. of Surg.*, New York, 1909, xxiii, 1-6.
- Smith, H. B.: Post-operative Acute Dilatation of the Stomach. *Boston Med. and Surg. Jour.*, 1909, clxi, 529-538.
- Smith, C. H., and LeWald, L. T.: The Influence of Posture on Digestion in Infancy. *Amer. Jour. Dis. of Child.*, Chicago, 1915, ix, 261-282.
- Speese, John: Acute Gastric Dilatation Following Operation for Hernia. *ANN. SURG.*, Phila., 1913, lviii, 702-704 (Abstract). Discussion: Hodge, E. B.
- Spitzka, E. A.: *Anatomy—Descriptive and Applied*, Henry Gray, Phila., New York, 1913, 1279-1280.
- Stierlin, R.: Ein Fall von akuter Magendilatation. *Cor. Bl. f. Schweizaerzte*, Basel, 1913, xliii, 1089-1093.
- Thomâ: Ueber akute post-operative Magendilatation. *Deut. med. Wchnschr.*, Berlin, 1908, xii, 501-504.
- Thomson, H. C.: *Acute Dilatation of the Stomach*, London, 1902, 54 p. Some Additional Remarks on the Etiology and Diagnosis of Acute Dilatation of the Stomach. *The Lancet*, London, 1902, ii, 287-288.
- Tissier, P. L.: Nature et traitement de la dilatation aigüe de l'estomac et des autres formes d'aerophâgie survenant après les interventions chirurgicales. *Bull. Gén. de Therapeutique*, Paris, 1910, clix, 61-69. Discussion: 69-73.
- Wilcox, R. W.: Acute Gastrectasis. *Arch. Diagn.*, New York, 1914, vii, 16-18.
- Witherspoon, T. C.: Post-operative Gastric Dilatation, *New York Med. Jour.*, 1912, xcv, 435-436.

THE INEFFICACY OF PYLORIC EXCLUSION BY FASCIAL BANDS*

AN EXPERIMENTAL STUDY

By HAROLD NEUHOF, M.D.
OF NEW YORK CITY

(From the Department of Surgical Research, College of Physicians and Surgeons, Columbia University)

WHEN it was shown that exclusion of the pylorus by the silk ligature method resulted in incomplete or too temporary closure,¹ attempts were made to occlude the pylorus by other materials. Of these, fascia offered the most promising possibilities, for it is a tissue of great resistance and remains viable, when transplanted, for a considerable period.² In 1908, Bogoljubow³ reported that he had obtained, experimentally, complete occlusion of the pylorus by ligation with fascia strips. The operation was performed on the human being by Wilms⁴ in 1911; subsequently by a number of other surgeons. Uniformly successful results were reported. The procedure bid fair to become the standard one for pyloric exclusion, and a difficult problem in gastric surgery appeared solved. Recently, however, a very few unsatisfactory results—*i.e.*, perigastric adhesions or patent pylorus—have been described. It thus became a question of interest to determine definitely if the experimental basis for the operation was entirely correct.

In analyzing the experimental studies that have been made, one finds that, in the work of Bogoljubow, the longest period of observation after operation was fifty days. That period was not appreciably longer in Protasoff's⁵ experiments, which substantiated the findings of the originator of the method. Von Tappeiner⁶ investigated the great variety of exclusions that have been advocated and found that the fascial

* Read at the December, 1915, meeting of the Surgical Section of the New York Academy of Medicine.

¹ At the present time there is no general agreement upon the desirability of complete or permanent closure, or even upon the indications for exclusion. Nevertheless, it is important to know what results may be expected after the application of any of the proposed and practised methods.

² The question of permanent viability is as yet unsettled, and is not considered in this paper.

³ Bogoljubow: Arch. f. klin. Chir., 1908, vol. lxxxv.

⁴ Wilms: Deut. med. Wochen., 1912, No. 3.

⁵ Protasoff: Tenth Russian Medical Congress, 1910.

⁶ Von Tappeiner: Bruns Beitr., 1912, vol. lxxx.

PYLORIC EXCLUSION BY FASCIAL BANDS

band method was the one satisfactory procedure. However, he performed only three exclusions by that method. His longest period of observation was two months. At the post-mortem examinations water escaped from the pylorus, drop by drop, in every instance. Very recently Gibson and Beekman⁷ have also reported a series of experiments dealing with various methods of pyloric exclusion. They strongly favor the fascia ring method for the human being, yet in only one of their seven experiments (observations were made as long as three months after operation) was a "functionally complete" occlusion obtained; in the remaining experiments the occlusion was termed "incomplete." The authors concluded that "there was undoubtedly some stenosis, and in all probability only a small amount of stomach contents passed through, the greater part going through the gastrojejunal anastomosis."

The details of technic of the experiments I performed need not be described. It will suffice to mention the two methods employed. Either the pylorus was tightly ligated with a strip of fascia lata knotted about it, or the fascia, as a broad band, was sutured snugly about the pylorus and infolded by two or three tiers of sutures. No-loop gastroenterostomies, with large stomata, were made. Table I summarizes

TABLE I

| Dog No. | Period after operation at which examination was made | Condition of pylorus |
|----------|--|---|
| 135..... | 5 days | Opened with maximal hydrostatic pressure. |
| 172..... | 6 days | Water-tight. |
| 131..... | 1 week | Opened with considerable pressure. |
| 157..... | 2 weeks | Patent. |
| 145..... | 3 weeks | Opened with moderate pressure. |
| 303..... | 3 weeks | Opened with considerable pressure. |
| 167..... | 1 month | Patent. |
| 118..... | 2 months | Patent. |
| 104..... | 2 months | Opened with moderate pressure. |
| 97..... | 6 weeks | Patent. |
| 82..... | 3 months | Opened with slight pressure. |
| 331..... | 5 months | Patent. |
| 341..... | 5 months | Patent. |

my results. Only once (Dog 172), at an examination made six days after operation, was the pylorus found completely water-tight. When the examinations were made at the end of one to three weeks it was usually found closed until the hydrostatic pressure within the stomach became high. Even in this period, however, the pylorus was found open in one experiment (Dog 157). It is of interest to note that the cause

⁷ Gibson and Beekman: ANN. OF SURG., 1915, vol. lxi.

for this (partial) exclusion observed shortly after operation appeared to lie in extensive peripyloric adhesions that generally developed, rather than in the constriction made by the band. In microscopic sections the fascia was found adherent to the gastric wall, but was evidently stretched, despite its great tensile strength, by the underlying musculature.

When post-mortem examinations were made one to three months after operation the pylorus either opened with moderate hydrostatic pressure or was quite patent. In the latter instance the fascial band was incorporated with the gastric wall, but it made a palpable ring that

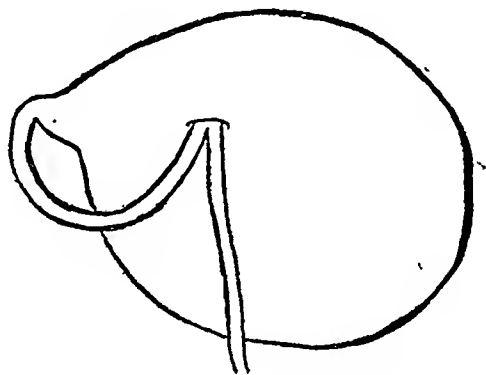


FIG. 1.—Extreme dilatation and rotation of the stomach after incomplete occlusion of the pylorus.

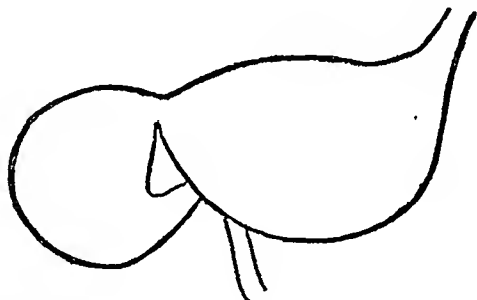


FIG. 2.—Dilatation of the duodenum after incomplete occlusion of the pylorus.

fitted loosely about the pyloric muscle. This was evident, too, in the microscopic sections. That the pylorus was widely open was certainly unquestionable at the post-mortem examinations five months after operation. In short, the error in the work of Bogoljubow and his followers was the brief period of observation after operation. Only very temporary pyloric exclusion results from ligation with fascial bands and even this cannot be expected to develop regularly.

A question that naturally arose was: Would pyloric exclusion by fascial bands be successful if the pylorus was first crushed? Several experiments were made to determine the point. In one, at the post-mortem examination two months after operation, the pylorus remained

PYLORIC EXCLUSION BY FASCIAL BANDS

closed with moderate, but opened with considerable, hydrostatic pressure. It was found patent, without water pressure, in the remaining experiments. Indeed, it was quite open in one of these experiments despite the fact that a large inflammatory tumor, closely surrounding the pylorus, had developed around some gauze sponges left near the stomach.

As a last effort to establish efficient pyloric exclusion with fascial strips the following operation was performed a few times: The stomach was opened near the pylorus, gauze sponges or strong tincture of iodine were vigorously rubbed into the pyloric mucous membrane, the gastric incision was closed, and the constricting fascial band then applied. These experiments were as unsuccessful as the previous ones, therefore the results need not be detailed.

Before closing, I wish to call attention to two deaths in the experimental series. They are presented because they appear to be directly ascribable to disturbed mechanical arrangements, the sequel of incomplete pyloric occlusion. Both animals were extremely emaciated and, at the post-mortem examinations, complete or almost complete retention of gastric contents was evident. In one (death one month after operation) there was enormous gastric dilatation and anterior rotation of the stomach (Fig. 1). The intestinal tract was quite empty. When the stomach was rotated backward gastric contents escaped into the duodenum through the pylorus and into the intestine at the stoma. The second animal died five months after operation. The stomach was markedly dilated, the pylorus was somewhat narrowed, and there was a tremendous dilatation of the first part of the duodenum (Fig. 2).

CONCLUSIONS

1. Experimental evidence of pyloric exclusion by fascial bands is incorrect, observations having been made too soon after operation.

2. Permanent pyloric occlusion does not follow experimental ligation with fascial bands.

3. Temporary pyloric occlusion is uncertain after experimental ligation with fascial bands.

4. Experimental pyloric occlusion by fascial bands is likewise unsuccessful after crushing the pylorus or after application of irritants to the pyloric mucosa.

5. Experimental pyloric ligation by fascial bands may be fatal, apparently from disturbed mechanical arrangements following incomplete occlusion.

6. The clinical application of pyloric exclusion by fascial bands therefore rests on an unjustifiable experimental basis.

POST-OPERATIVE INTESTINAL OBSTRUCTION*

BY CHARLES LANGDON GIBSON, M.D.

OF NEW YORK

SURGEON TO THE FIRST (CORNELL) DIVISION OF THE NEW YORK HOSPITAL

INTESTINAL obstruction as a result of operation, recent or late, furnishes us to-day with the largest number of cases requiring surgical interference. This fact is demonstrated very clearly from the operative material in my service at the New York Hospital for the last three years. Thirty-four operations have been performed for intestinal obstruction; of these, no less than 24 (70 per cent.) were due to the sequelæ of a previous operation. Seven of these cases followed directly as a complication of operation, while the patient was still in the hospital.

Post-operative intestinal obstruction is of two kinds: one directly follows and complicates an abdominal operation, the second results from the subsequent formation and persistence of adhesions due either to the performance of an operation or the existence of conditions underlying such operations. With the great increase of abdominal operations it is but quite natural, that there should be a seeming increase in the number of post-operative obstructions.

I will take up first the consideration of that form of obstruction which comes after the patient has successfully convalesced from an operation. Such cases have generally been classified under the heading of adhesions and, as it is well known, adhesions form the largest single variety of acute mechanical obstruction. The next variety of mechanical obstruction as a definite entity is intussusception, and in my studies on that subject (Intestinal Obstruction, *ANNALS OF SURGERY*, 1900, vol. xxxii, page 486) I found that as reported in literature these two varieties have very nearly the same frequency. There is, however, an inconsistency in these figures. Intussusception is such a clearly defined mechanical condition, so easily diagnosticated and presenting so many points of interest, that it is probably more frequently reported in literature than adhesions. To classify these post-operative obstructions as adhesions, however, does not to my mind sufficiently identify them as distinct lesions, and one object in writing this paper is to call attention to and emphasize the special importance, frequency, and gravity of this con-

* Read before the New York Surgical Society, January 12, 1916.

POST-OPERATIVE INTESTINAL OBSTRUCTION

dition. In late obstruction the time elapsed from the previous operation was 25 days, 3 months, 4 months, 9 months, 1 year, 15 months, 2 years, 2½ years, 4 years, 6 years, 7 years, 8 years, and 21 years. In three cases the source of obstruction could be traced to the presence of an irreducible prolapse through an incisional hernia.

In a large proportion of cases the obstruction developed apparently somewhat insidiously; presumably, a chronic incomplete obstruction finally became more pronounced or complete, and we know of several instances in the series which were observed by competent practitioners at the outset but the possibilities not recognized until the symptoms were unmistakable, necessitating an operation with very small chances of recovery. If in these cases the possibilities and probability of an intestinal obstruction developing as a result of former operation had been kept in mind, the diagnosis would probably have suggested itself at a very much earlier period. It is for this reason that I would plead that a classification of the mechanical forms of acute intestinal obstruction should include these cases under a definite heading that should be as distinct as the classification of intussusception or volvulus or Meckel's diverticulum. Improvement in both diagnosis and therapy has been made in recent years but there still remains room for more. The mortality of this series is 58 per cent. for operations, both late and occurring in the convalescence; 57 per cent. for those occurring late, and 43 per cent. for those occurring in convalescence. In my paper alluded to above, I found that the mortality of operations for relief of intestinal obstruction due to adhesions was 42 per cent. This percentage is probably overfavorable, as cases collected from the literature are apt to be; whereas the cases forming the subject of this paper represent the consecutive and total material of a hospital service.

What prospects of prevention of this condition can we expect? In general terms it may be stated that the degree of perfection of technic and completeness of performing any abdominal operation will diminish the dangers of subsequent mishaps; that is, operations done with a minimum of trauma, with a minimum of raw surface, without drainage, with a complete closure of the abdominal wall and primary union should naturally give the best guarantee. It must be remembered, however, that the formation of adhesions to some degree is probably an almost necessary sequel to even the simplest and most perfect of operations. It is probable that in a considerable number of operations some slight degree of adhesions is formed at the site of operation which, however, is only temporary and disappears. It is probable that

a certain amount of temporary gluing of the omentum, less frequently of the intestine, takes place at the site of closure of the peritoneal incision. Adhesions of the most damaging nature may, however, result from the most satisfactory technic. I can remember having to operate for intestinal obstruction following the performance of an interval appendectomy with most satisfactory technic and inversion of the appendiceal stump. If the original operation has been unsatisfactory either through the necessity of drainage or of imperfect healing of the abdominal wall, it will be the part of wisdom to subject such patients, providing they are in good health and there are no serious counterindications, to a plastic repair of the abdominal wall which will effectually guarantee against the formation of subsequent herniæ. With our modern technic, it is much easier to perform such operations than formerly and, with rare exception, even the largest of these post-operative herniæ can be successfully operated upon.

I now am operating on these large herniæ (Figs. 1 and 2)¹ which formerly we used to consider inoperable by closing the opening with fascial flaps, and this procedure seems applicable and efficient to the worst forms of these herniæ. The exact description of this procedure will be the subject of a paper in the near future.

A device which I have used for some years when drainage of the abdomen is required in considerable amounts is the employment of the principle of the Mikulicz tampon by using a large piece of dental rubber dam with perforations. Into this is introduced a considerable amount of gauze packing. This gauze packing, being under a certain pressure, efficiently keeps the intestines or omentum away from the abdominal incision. In the course of a few days these structures will become fixed by adhesions and no longer tend to prolapse through the wound. When drainage is discontinued the sides of the abdominal incision may be drawn over the drained space and there will be little or no tendency for the intestine or omentum to protrude through the drainage opening (Fig. 3). In operations upon the female pelvic viscera requiring drainage, I believe it is very important if any drainage is used at all (and the cases are very few) to close the abdominal wall completely and provide for drainage through Douglas's cul-de-sac. A particularly efficient form of drainage, as after a supravaginal hysterectomy, is to split the stump posteriorly through the cervical canal to the vaginal reflection. The drainage tract is lined by mucous membrane, will not close readily and gives admirable and free drainage.

¹ I am indebted to Dr. Clay Ray Murray, House Surgeon of the New York Hospital, for making the original drawings of the illustrations for this article.

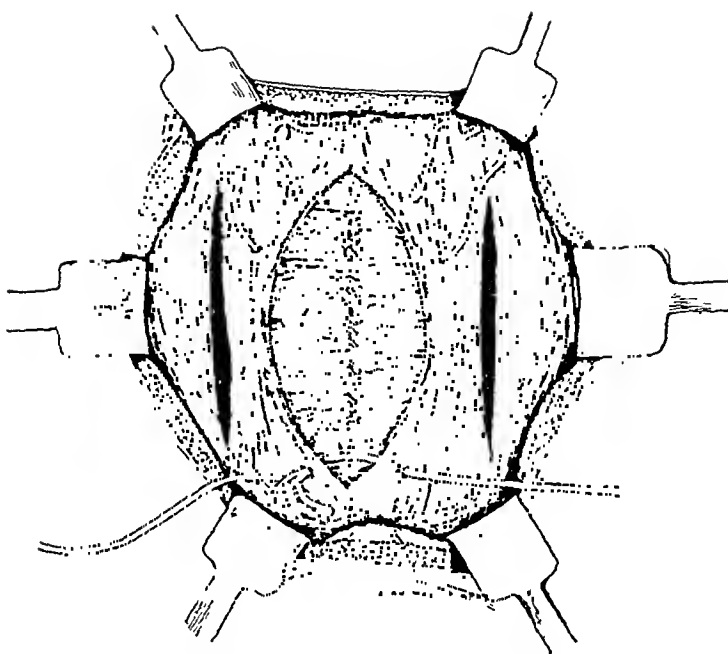


FIG. 1.—Releasing incisions in the fascia of the rectus muscle parallel to the line of suture.

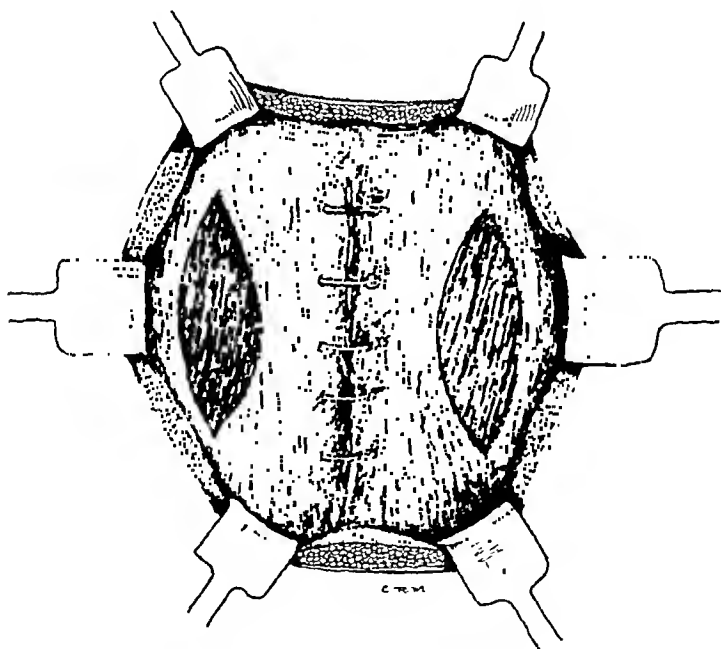


FIG. 2.—Edges of fascia reunited in midline without tension.

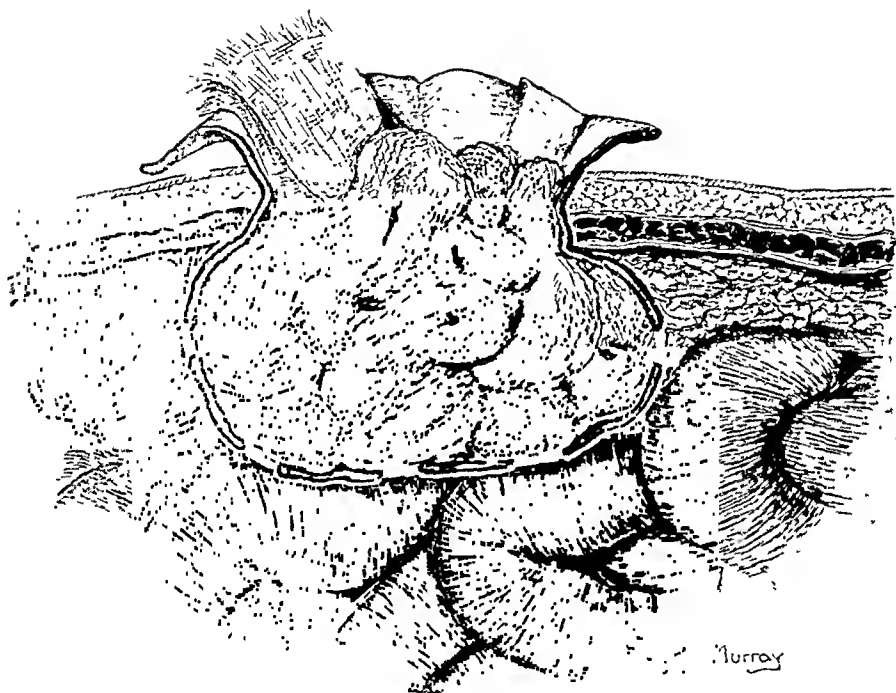


FIG. 3.—Rubber dam Mikulicz tampon.

Some of these cases of post-operative obstruction by bands offer considerable complexity as regards the extent and multiplicity of the obstructive agents. I found in my analysis (see above) that one-third of the fatal cases in obstruction by band were due to the overlooking of an unrelieved obstruction. While many of the obstructions by bands are well defined and may show injury to the vitality of the intestine requiring resection, other cases may show a diffuse matting without any one predominant strangulation or definite injury to the blood supply of the gut. In these cases, if one can feel fairly certain that the blood supply is all right, an entero-anastomosis of the loops entering and leaving the tangled area will prove to be a shorter, simpler and much safer operation. Moreover, after diversion of the fecal current, probably an improvement will take place in the conditions of the affected gut just as we see a stricture of the œsophagus relax after gastrostomy. The series of cases reported here does not contain any such operation, but on reviewing them I believe that we might have employed this procedure in some cases with betterment of our results.

Obstruction Directly Following Operation.—This form of obstruction is fairly frequent and is of two different kinds—one mechanical, the other paralytic. In many cases it is difficult or impossible to tell which variety is present.

The mechanical form is due to agglutination of the coils of intestine and omentum to each other or to the abdominal wall. A mild degree of this condition probably obtains in a large proportion of abdominal operations and, although never becoming dangerous, may be a disturbing factor in the convalescence. As I stated before, probably a considerable proportion of these agglutinations spontaneously disappear. It is my belief that these very mild forms of agglutination are easily overcome when intestinal peristalsis is reëstablished, and, therefore, as a matter of prophylaxis, I believe the securing of early peristalsis is indicated for the preventing of this as well as for the second, or paralytic, variety.

In general terms, definite mechanical obstruction by these adhesions does not ordinarily come on directly after operation, whereas the second or paralytic occurs chiefly in the course of the first few days. In a typical case of mechanical obstruction the immediate convalescence at first will probably show little or nothing to indicate what is coming; in fact, the patient may feel well, the course will be relatively afebrile, post-anæsthetic nausea and vomiting will have ceased, and a stool and flatus may have been passed. The abdominal distention, if any, will be

moderate. Suddenly, say in from five to ten days, the patient's general demeanor will change and it is obvious that his condition has become worse. The first symptom usually will be vomiting, and this vomiting will be repeated and particularly early if the obstruction is in the upper part of the intestine. Distention at first may or may not be obvious. The obstruction usually involves the small intestine, distention therefore not being as great as in obstruction lower down. This absence of obvious distention may be very misleading. At this stage the patient is ordinarily given a brisk cathartic followed by an enema. Following the enema the nurse will report that the patient has had a large stool and feels better. This is a most disastrous event, as the lower bowel only has been evacuated and the patient's condition remains unchanged. We are also informed frequently that after the passage of the enema or the rectal tube the patient has passed gas. We should never be satisfied with the statement that the patient has passed gas unless it is independent of such manipulations. There is no question that the diagnosis is often very difficult. One hesitates naturally very strongly to offer to a patient whose strength and courage have been much reduced by a recent operation the necessity of reopening the abdomen, and those of us who have been through this know how difficult an operation may be under these conditions. When time allows, that is, when the symptoms are not very acute and the patient's condition is good, it has been my custom to demonstrate, if possible, whether or not the intestinal tube is patent by the administration of powdered charcoal followed by a brisk cathartic. If the charcoal comes through within a few hours of course we have a convincing demonstration that a complete occlusion at least does not exist. The helpfulness of this procedure is well illustrated in the following case:

(Case 14.) Appendectomy 4 years ago. Admitted March 5, 1914. Nineteen days previously began to have evident symptoms of increasing obstruction. On admission patient was quite ill, was vomiting, abdomen distended. Given a half ounce of charcoal. Next day stool colored with charcoal. Did not vomit all day. Slept well. March 7, vomited again but condition remained good. March 8, more charcoal given which later was vomited. At operation an obstruction was found resulting from adhesions of the cæcum to the mesentery of the ileum. The obstruction was then apparently total.

Paralytic Ileus.—By paralytic ileus we mean for the most part the arrest of peristalsis coming in the presence of a septic process and

POST-OPERATIVE INTESTINAL OBSTRUCTION

presumably due to it. There probably is a very much smaller class in which no septic manifestations are present but merely a reflex inhibition as the result of the irritation or shock of operation. One sees occasionally such a condition developing spontaneously in elderly people after an injury which puts them to bed but has not directly acted upon the abdomen. Such a degree of stasis would ordinarily yield to time or to the influence of acceleration of peristalsis. It must, however, be presumed that the intestine will act as will the bladder, in that a certain amount of distention increases its already diminished tonus, and I can remember cases which have ended fatally, without obvious inflammatory manifestations, which might have been saved if earlier and more energetic measures at securing peristalsis had been employed.

The picture of paralytic ileus is ordinarily that of septic peritonitis coming more particularly after operations for the relief of conditions such as appendicitis or intestinal obstruction. The patient's general condition is that of sepsis; the abdominal symptoms are particularly those of tympanites, pain, tenderness and marked rigidity of the abdomen, persistent and repeated vomiting and the absence of stool or flatus. The condition is progressive and the patient dies usually in about three days. It will be noted that there is no response to catharsis. Some one has remarked that it is like trying to medicate a lead pipe. There may sometimes be an appreciable difference between this form and mechanical obstruction. In the latter there may be some attempts at peristalsis in the proximal segment of the gut, as evidenced by a certain amount of gurgling and cramp-like pain referred to at some definite point of the abdomen, perhaps corresponding to the site of the obstruction.

In former years, like most of my colleagues, I thought that the inhibition of peristalsis resulting from a peritonitis could not be cured. I must acknowledge to-day that probably the graver forms must necessarily be fatal, but my experience with a new form of therapy in the last three years leads me to think that many of these cases can be saved, intestinal function reestablished and the patient recover providing the degree of existing sepsis is not too virulent to be overcome by the body resistance. I refer now to the use of pituitrin which I consider a veritable life-saver and which, perhaps, has given me my chief excuse for writing this paper. All previous forms of intestinal excitants had failed me in grave cases, including eserin, the deadly hormonal, intravenously, and even the unjustifiable croton oil. Enterostomy, although

giving an occasional success to an occasional operator, has never seemed to me of value in treating paralytic ileus and certainly has never succeeded with me. Admitting for the sake of argument that enterostomy may rarely overcome a paralytic ileus I feel very strongly that it should not be resorted to until a trial with pituitrin has been made.

My attention to the possible value of pituitrin was suggested in 1912 when I learned of its value in stimulating uterine action and it occurred to me then that what was good for one smooth muscle might be good for another. At that time, so far as I knew, its use as a peristaltic accelerator had not been tried, although I find from subsequent investigation that Moynihan gives credit to Blair Bell (*British Medical Journal*, December 4, 1909) for the use of pituitrin as a stimulant for the intestinal muscle. I began to use it in all such cases and have used it frequently ever since and am now firmly convinced of its value.

ILLUSTRATIONS OF USE OF PITUITRIN

CASE I.—Mrs. E. Seen in consultation forty-eight hours after laparotomy for tubo-ovarian condition. Twenty-four hours after operation pulse 140, temperature $104\frac{1}{2}^{\circ}$. When seen by me presented a condition of septic peritonitis. Abdomen markedly distended, tender and rigid all over. Two doses of pituitrin were given, followed by passage of flatus and stool, prompt relief of symptoms and eventually good recovery.

CASE II.—Mrs. P. Hysterectomy one month previously. Symptoms of increasing partial obstruction for about a week. Apparently of mechanical variety and not complete. One dose of pituitrin was followed by marked collapse, but patient passed gas and had a stool fifteen minutes later; made a prompt recovery as regards obstruction. Convalescence delayed, as patient was markedly septic with streptococcus viridans, but eventually recovered completely.

CASE III.—C. A., ten years old. Appendicitis of seven days' duration, general peritonitis, post-operative, much distended, and after two days' vomiting received small amount of pituitrin. Flatus was passed and night was noted more comfortable than any he had had. He received subsequent doses of pituitrin on the third and fourth days. The administration of the first dose seemed to mark a turning point in the progress of the case.

CASE IV.—Miss F. (Case 8). Intestinal obstruction and general peritonitis. Resection of two feet of terminal ileum. On the third day after operation patient vomited four times. Enema not effectual. Late that day pituitrin given, second dose in two hours.

POST-OPERATIVE INTESTINAL OBSTRUCTION

Next day three doses of pituitrin were given. After the second dose enema given; returned light brown in color with some fæces. After third dose flatus was expelled by rectum and a few hours later considerable flatus expelled with some fecal matter. Patient made a good though tedious convalescence.

CASE V.—Mrs. B. (Case 18). Salpingo-oöphorectomy three months previously. No movement of the bowels for five days. Obstruction evidently in descending colon. Patient's condition was good. First dose of pituitrin given at 8.45 A.M., on day of patient's admission. 9.30 A.M., enema returned brown fluid with many particles of brown fecal matter. Considerable flatus expelled 10.45 A.M., second dose of pituitrin. 11.45 A.M., quantity of flatus expelled. 12.45 P.M., third dose of pituitrin. 1.00 P.M., quantity of flatus expelled. Subsequently an artificial anus was made in the cæcum in two stages, there being an interval of five days.

Of late I think many operators are using pituitrin and with good success, but at the same time I am astonished to find men of large experience who have no knowledge of its possibilities. For instance, within six months one of the most active surgeons in America described a successful case of enterostomy for paralytic ileus. I asked him if pituitrin had been unsuccessful in this case and he stated that he was not aware of its value. I find little reference to it in recent standard works on surgery. In Johnson's *Operative Therapeutics*, 1915, it is stated under the section on appendicitis that in paralytic ileus "recently pituitary extract has given excellent results in a few cases." *Murphy's Hand-book*, 1915: "Pituitrin was used with good result in two cases of intestinal obstruction by N. Porritt." Moynihan, *Abdominal Operations*, Third Edition, 1914: "I have tried the substance in perhaps a dozen cases . . . that it is without doubt a valuable if a capricious remedy."

The Methods of Using Pituitrin.—In any form of organotherapy it is most important to have fresh and stable solutions. I am not personally familiar with the comparative merits of the various preparations on the market. The only one that I have used is made by a firm enjoying a good reputation for the reliability of its products. The pituitrin is administered hypodermatically in the muscles. It has been my custom, depending on the necessities of the case, to give an ampoule (1 c.c.) of the preparation and repeat every hour up to three doses; subsequent doses two hours apart. I have never given more than five doses in twenty-four hours. For cases of the milder variety the second injection usually brings about the passage of gas in considerable quan-

tities and often causes a spontaneous stool. The effects may of course be reënforced by a suitable enema.

As yet, I have not felt it wise to use pituitrin intravenously, as is recommended by some, though it is possible that I may do so, using it in small quantities. In Case II the whole dose was evidently accidentally administered intravenously. It was followed at once by a terrific collapse endangering the patient's life, but she subsequently recovered not only from the collapse but also from the obstructing condition.

Any form of hypodermatic medication which, like pituitrin, can be administered without resulting irritation to the stomach of course presents great advantage, especially in those conditions in which the patient has a tendency to vomiting as will naturally exist in most of these cases for which pituitrin is indicated. In fact, so pleasant is the effect of pituitrin that I occasionally use it in the less serious cases where medication by mouth is unpleasant, or pretty quick results are desired.

SUMMARY OF TWENTY-FOUR CASES OF POST-OPERATIVE OBSTRUCTION

(A) OBSTRUCTION OCCURRING IN CONVALESCENCE

| Case | Duration of obstruction | Part of intestine involved | Operation | Time elapsing from previous operation | Result | Original operation | Male or female |
|------|-------------------------|----------------------------|-------------------------|---------------------------------------|--------|-------------------------------|----------------|
| 1 | 5 days | Small intestine | Artificial anus | 16 days | Died | Ineisional hernia | Female. |
| 2 | 2 days | Small intestine | Separation of adhesions | 6 days | Died | Appendix | Male. |
| 3 | 24 hours | Small intestine | Artificial anus | 10 days | Died | Appendix | Male. |
| 4 | 24 hours | Small intestine | Separation of adhesions | 14 days | Cured | Appendix | Male. |
| 5 | 36 hours | Small intestine | Artificial anus | 5 days | Died | Pelvic organs | Female. |
| 6 | 24 hours | Small intestine | Artificial anus | 2 days | Died | Strangulated umbilical hernia | Female. |
| 7 | 24 hours | Small intestine | Artificial anus | 5 days | Died | Appendix | Female. |

(B) LATE OBSTRUCTION

| Case | Duration of obstruction | Part of intestine involved | Operation | Time elapsing from previous operation | Result | Original operation | Male or female |
|------|-------------------------|----------------------------|-------------------------------|---------------------------------------|--------|-----------------------------|----------------|
| 8 | 36 hours | Ileum | Resection | 15 months | Cured | Appendix | Female. |
| 9 | 3 days | Ileum | Resection | 1 year | Died | Appendix | Female. |
| 10 | 2 days | Ileum | Resection | 1 year | Cured | Pelvic organs | Female. |
| 11 | 2 days | Small intestine | Artificial anus | 9 months | Died | Pelvic organs | Female. |
| 12 | 24 hours | Small intestine | Artificial anus and resection | 21 years | Died | Pelvic organs | Female. |
| 13 | chronic | Cæcum | Separation of adhesions | 8 years | Cured | Pelvic organs | Female. |
| 14 | 19 days | Small intestine | Cutting of band | 4 years | Cured | Appendix | Male. |
| 15 | 2½ months | Small intestine | Separation of adhesions | 3 months | Cured | Appendix | Male. |
| 16 | 4 days | Small intestine | Separation of adhesions | 6 years | Cured | Appendix | Female. |
| 17 | 3 days | Small intestine | Separation of adhesions | 2 years | Died | Pelvic organs | Female. |
| 18 | 5 days | Large intestine | Artificial anus | 3 months | Cured | Pelvic organs | Female. |
| 19 | 3 years | Cæcum | Separation of adhesions | 8 years | Cured | Pelvic organs | Female. |
| 20 | 1 month | Small intestine | Resection | 3 months | Died | Appendix | Male. |
| 21 | 1 day | Lower ileum | Separation of adhesions | 2½ years | Died | Strangulated ventral hernia | Female. |
| 22 | 2 days | Ileum | Cutting of band | 25 days | Cured | Appendix | Male. |
| 23 | 2 days | Small intestine | Separation of adhesions | 4 months | Died | Pelvic organs | Female. |
| 24 | 4 days | Small intestine | Artificial anus | 7 years | Died | Pelvic organs | Female. |

Total.—Twenty-four cases: Male, 7; female, 17.

Deaths, 14: Occurring in convalescence, 6; occurring late, 8.
In 10 cases previous operation for diseases of female pelvic viscera.

THE PREVENTION OF FECAL FISTULA IN SUPPURATIVE APPENDICITIS

By DONALD GUTHRIE, M.D.

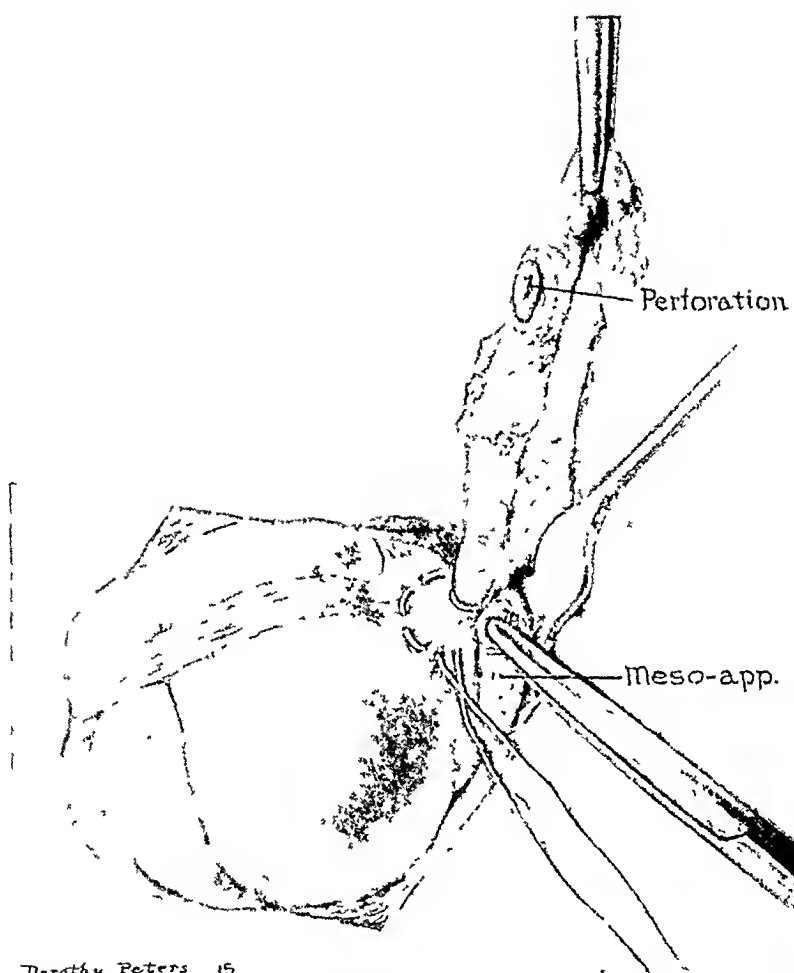
OF SAYRE, PA.

SURGEON TO ROBERT PACEER HOSPITAL

GRANTED that we are operating for ruptured or suppurative appendicitis, are there any measures to be carried out that will safeguard the patient against the development of a fecal fistula? We believe that there are, in spite of the fact that fistulæ occasionally develop in cases where no attempt has been made to remove the appendix, and, too, that some surgeons who pay no particular attention to the treatment of the stump in these cases do not get fistulæ. In describing this method, we realize that there are several ways of doing the same thing correctly and undoubtedly many ways different from ours that have worked just as well in the hands of other surgeons.

We consider the following factors of importance. First, the incision. Our choice is the muscle splitting or McBurney in most of the cases. In those who have well-defined abscesses lying near the midline, we make a straight incision over the most prominent part of the mass. A muscle splitting incision gives a better post-operative wound, I believe, especially should sloughing occur. There will not be as much gaping and this will not allow as much of the cæcum to become adherent to the edges of the incision. Protrusion of the cæcum through the wound may cause a fecal fistula. The liability of post-operative hernia is less if this incision is used.

Second, treatment of the stump. Whenever possible we invert the stump, using an absorbable purse-string suture of catgut after it has been carefully ligated with catgut. A second purse-string or a few interrupted sutures of catgut are used for further reinforcement. Permanent sutures of linen or silk in the presence of infection are prone to be followed by a persistent sinus and I have operated on fistula cases in which I have been able to recover the suture. When perityphlitis is present to a marked degree and the head of the cæcum has become so thickened by inflammation that inversion of the stump is impossible, we resort to the old cuff operation, turning down a fold of the thickened peritoneal coat, ligating the stump with catgut and then covering it over with the cuff tied by catgut. These methods are better, I believe,



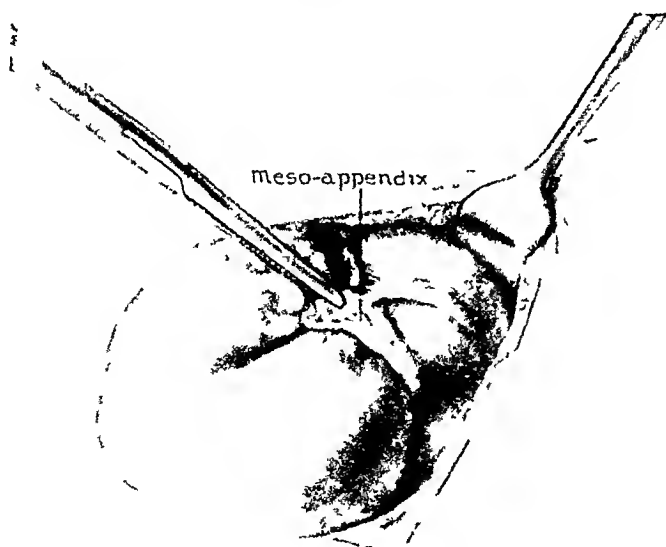
Dorothy Peters 15

FIG. 1.—Showing purse-string suture of catgut and clamp on severed meso-appendix.



Dorothy Peters 15

FIG. 2.—Purse-string suture tied. Reinforcement with several interrupted sutures of catgut.



J. C. Peters 15

FIG. 3.—Meso-appendix drawn over suture line and secured

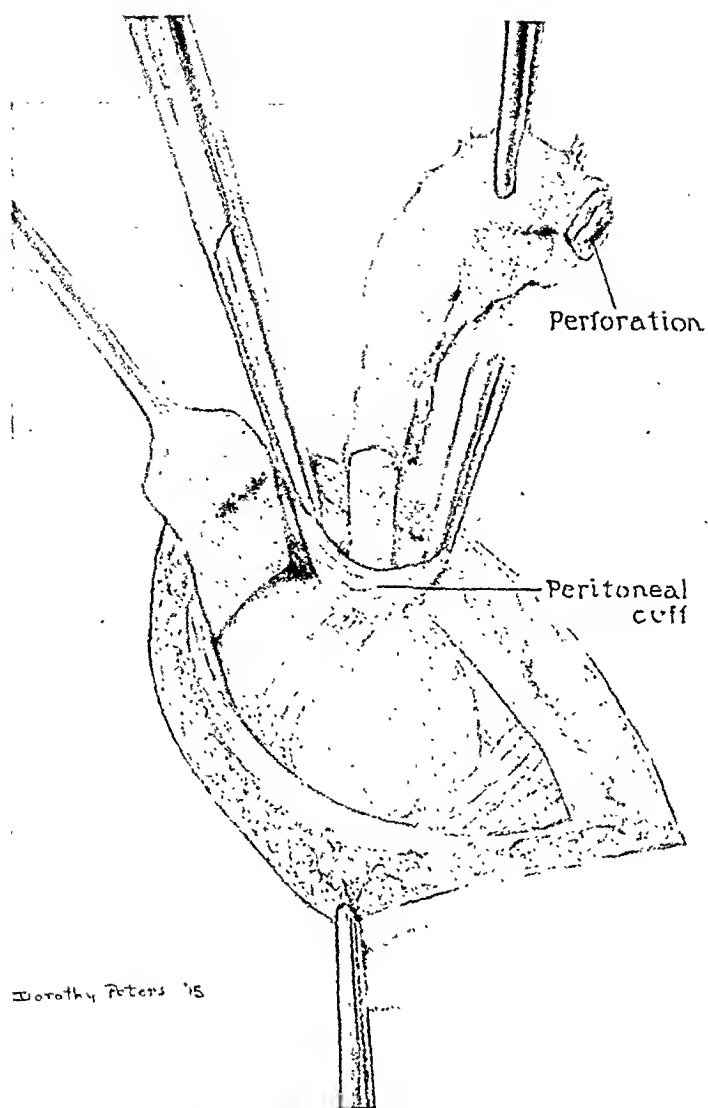


FIG. 4.—The peritoneal cuff operation is employed when it is impossible to invert stump.

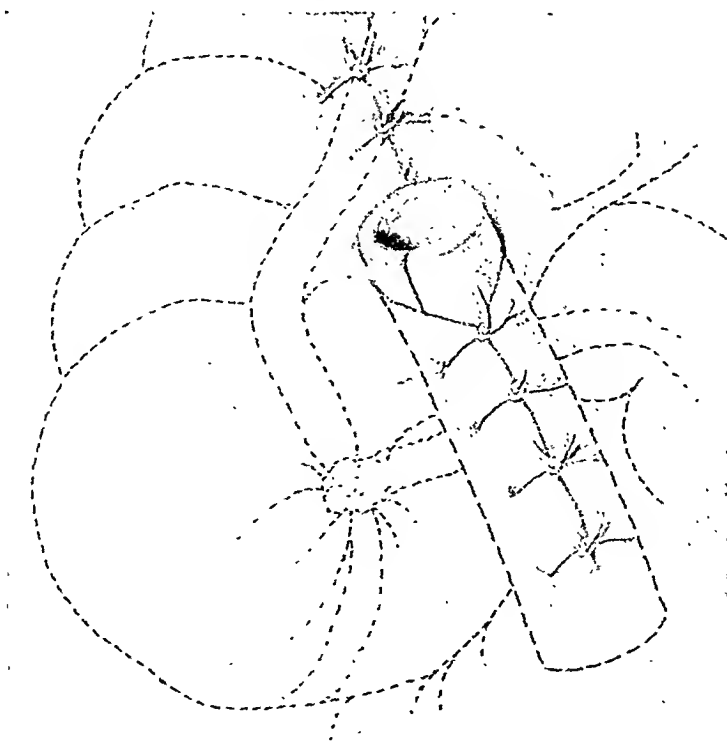


FIG. 5.—Diagram showing drainage tube placed well away from head of cæcum.

FECAL FISTULA IN SUPPURATIVE APPENDICITIS

than simply tying off the stump and dropping it back into the abdomen. After the stump has been inverted by the catgut suture, or the cuff operation employed, we aim to further reinforce the field by tying in the cut meso-appendix. This is not possible in every case, and when impossible, we use a tip of omentum if it can be found or some organized lymph from an abscess wall.

Third, drainage. We never use gauze as a drain *per se* as it will not drain pus after a few hours, but it is occasionally used to control hemorrhage, and whenever it is used it is placed well away from the head of the cæcum and removed as early as possible. Gauze placed near a suture line, especially a permanent suture line, will tend to cause fistulæ. We never employ drainage in any form of abdominal tuberculosis, believing that a mixed infection with this condition is almost sure to develop a fecal fistula.

Our drainage tubes are of soft rubber and of large calibre. They are placed away from the head of the cæcum as far as possible, shortened early, and removed, as a rule, by the end of the first week. Fistulæ have been caused in some cases by a too prolonged contact between the head of the cæcum and the drainage tube. We never give laxatives until all drains have been removed.

In the past five years and three months (June, 1910-1915) my associate, Dr. S. D. Molyneux, and myself have performed 2,658 abdominal operations. Of this number 1,114 were operated upon for appendicitis primarily and do not include 698 cases in which diseased appendices were removed during the course of other operations. Of the 1,114 appendix cases, 298 patients had ruptured, gangrenous, or suppurative appendices in whom drainage was employed. Besides this number we have drained the abdomen in 555 cases for other infections, making a total of 853 drainage cases.

We have had three fecal fistulæ develop in the 853 drainage cases. One, following a pyosalpinx operation, which healed spontaneously; one, the drainage of a large appendiceal abscess, in which no attempt was made to locate the appendix—this fistula healed spontaneously; one, a fistula developed in the case of a boy who was operated upon for ruptured appendicitis with general peritonitis. The abdomen was drained freely. The boy required gastric lavage every three hours for four days and I believe the trauma to the head of the cæcum by the tubes caused this fistula. He required operation to close two holes in the head of the cæcum.

RECENT CLINICAL AND PATHOLOGICAL OBSERVATIONS ON GIANT-CELL MEDULLARY BONE TUMORS*

By F. R. HAUSSLING, M.D.

OF NEWARK, N. J.

SURGEON, CITY HOSPITAL

AND

H. S. MARTLAND, M.D.

PATHOLOGIST, CITY HOSPITAL

PART I. REPORT OF A HITHERTO UNDESCRIBED FORM OF MULTIPLE BONE TUMORS. MULTIPLE NON-SUPPURATIVE CHRONIC HEMORRHAGIC OSTEOMYELITIS

THIS case presents multiple expansive bone tumors, the clinical picture resembling that of multiple myeloma; the microscopical appearance of the tumors, however, is that of the so-called medullary or myelogenous giant-cell sarcoma or chronic non-suppurative osteomyelitis of Barrie.¹ Multiple tumors presenting this microscopical appearance have hitherto been undescribed.

CASE I.—*History*.—T. K., female, age twenty-five years, married, housewife, admitted to City Hospital June 2, 1915. Family history negative. Past history, had measles in childhood. Denies venereal disease. Has had four normal births, one miscarriage. In February, 1914, patient had a miscarriage, she lost considerable blood and has never been well since, complains of weakness, dyspnoea and palpitation on exertion. In August, 1914, she, for the first time, noticed an enlargement of the right superior maxilla. In October, 1914, she fell and broke her right femur, about six inches above the knee-joint; treatment in the City Hospital resulted in firm union without deformity. In February, 1915, she noticed a second mass on the anterior surface of the left tibia, about its middle third. This grew for two months and attained the size of a hen's egg; it since has remained stationary in size. In May, 1915, she gave birth to a full-term healthy child. In June, 1915, she was admitted to City Hospital complaining of dyspnoea, weakness, cardiac palpitation and slight bone pains.

Physical Examination.—Showed a well-developed female, with fair nutrition (Fig. 1). Saddle nose, due to trauma in childhood. Heart in sixth interspace, outside nipple line, with a loud systolic murmur. Lungs, suspicious signs of early tuberculous involvement of left upper lobe. Physical examination otherwise negative,

* Presented before the New York Pathological Society, November, 1915.

GIANT-CELL MEDULLARY BONE TUMORS

with exception of multiple, palpable bone tumors, varying in size from that of an English walnut to that of a hen's egg, and situated as follows: The inner wall and floor of right orbital cavity, and superior maxilla; the left clavicle, at its sternoclavicular articulation; the right clavicle near its acromial end; the left tibia on its anterior surface, near its middle third; and the seventh rib on the right side.

Röntgenograms (Figs. 2, 3, 4, 5 and 6) showed in addition to the palpable tumors, expansive tumors in the following locations: The right femur above the knee-joint; right fibula, upper third; and left fibula, upper third. Later röntgenograms showed a tumor developing in the right humerus just above the elbow and one in the pelvis.

Laboratory Examination.—The following laboratory examinations were made: Hæmoglobin, 75 to 85 per cent.; erythrocytes, 4,020,000, no abnormals; leucocytes, 5200 to 9600, no abnormals; blood Wassermann negative, three times; spinal fluid Wassermann negative, with normal cell count and globulin. Several 24-hour urine specimens were examined, especially for Bence-Jones albumose, with negative results. The urine always showed a trace of albumin, with a small number of hyaline and granular casts. Otherwise the urine was normal.

Clinical Diagnosis.—Multiple myeloma, cardiac dilatation and failing compensation.

Progress Notes.—On June 28, 1915, in order to establish a positive diagnosis, we removed the growth on the left tibia with the curette, revealing a small localized cavity containing what appeared to be well-organized red granulation tissue with considerable bleeding. The cavity was swabbed with pure carbolic followed by 95 per cent. alcohol, and wound sutured tight. Wound healed by first intention. On microscopic examination of this tissue, we were surprised to find the typical lesion of the so-called giant-cell myelogenous sarcoma. Believing this to be a benign lesion, from previous experience, we decided to attempt to remove by means of the curette all of the accessible tumor masses. On August 16, 1915, a second operation was performed, exposing and curetting growths on the right fibula, left fibula, left clavicle, right clavicle, seventh right rib, and right superior maxilla. These lesions varied from the size of a pigeon's egg to that of a hen's egg, all tumors were covered by smooth, bulging periosteum, were sharply localized with no tendency whatever to break through their bony shell and consisted of what appeared to be firm red granulation tissue, which curetted away in small masses. After thorough curettage the smooth wall cavities were swabbed out with carbolic and 95 per cent. alcohol, allowed to fill with blood

and the skin wounds sutured without drainage. The wounds united by primary union.

Microscopic Examination.—Microscopic examination of the tissue removed from the various tumors showed in each case the typical picture of the so-called myelogenous giant-cell sarcoma (Figs. 7, 8, 9, 10, 11 and 12).

Subsequent Notes.—The patient's physical condition has greatly improved, and her cardiac condition has become fully compensated. The tumors curetted still show in röntgenograms, and new ones are slowly making their appearance. On November 26, 1915, the lesion on the lower end of the right humerus was incised; this tumor mass proved to be quite cystic, with very little of the characteristic tissue in its walls.

Summary.—So far as we can find:

(1) Multiple, primary, expansive, slow-growing bone tumors, with the clinical picture of multiple myeloma but with the histological picture of chronic non-suppurative hemorrhagic osteomyelitis (giant-cell sarcoma), have hitherto been undescribed.

(2) The tumors are too numerous to consider trauma as an etiological factor.

(3) It is of course impossible to say what the ultimate outcome of this case will be. Although the disease is undoubtedly not arrested, as is conclusively shown by the appearance of new lesions, there has been up to the present time no tendency for the growths to break through their bony covering, or infiltrate the surrounding soft parts or form metastases. Nor has the patient's general health deteriorated.

Treatment.—All accessible tumors should be removed with the curette, swabbed out with phenol and alcohol, the cavity allowed to fill with blood clot and the skin wound closed without drainage. We feel that this is the logical treatment, since it has been proved to be curative in so-called giant-cell sarcoma having the same histological picture, and also it relieves the moderate pain which accompanies these growths.

PART II. REPORT OF A CASE OF GIANT-CELL MEDULLARY TUMOR OF THE USUAL TYPE, NAMELY A SINGLE BONE TUMOR

This case presents an expansive tumor involving the lower end of the right tibia, of over eight years' duration, which on microscopical examination shows the typical picture of the so-called medullary or myelogenous giant-cell sarcoma. We present this case to demonstrate the benign character of this type of tumor and its chronicity.

CASE II.—A. L., Italian, twenty-eight years of age, barber, admitted to City Hospital March 14, 1910. Discharged June 5,

GIANT-CELL MEDULLARY BONE TUMORS

1910. Family history negative. Personal history, chancre when eighteen years of age, treated one year.

Present History.—Three and one-half years prior to admission, while playing ball, patient stepped into a shallow hole twisting his ankle so that he was immediately unable to support his weight on it. Pain, swelling and disability persisting, the ankle was encased in plaster for about three weeks. Following this, antiluetic treatment was instituted for one month. The ankle failing to improve was again put up in plaster for one and one-half months; there being no improvement at the end of this time, he entered the hospital, where the lower end of the tibia was curetted, but no diagnosis made. He left the hospital at the end of five weeks and had no further trouble for eighteen months, when the swelling and pain gradually returned. The lesion was again curetted, after which he was able to work at his occupation for about seven months. In January, 1910, he fell and again injured his ankle; considerable bleeding taking place from the sinus which has persisted since his last operation. On admission to the Newark City Hospital, March 14, 1910, patient complained of intense pain in left ankle, markedly aggravated by walking, and presented a uniform enlargement of the lower end of the tibia, very little if any smaller than its present size with a healed scar on the inner aspect. The skin over the enlargement was otherwise normal in appearance. On palpation there was moderate tenderness. No egg-shell crackle. The patient has lost 25 pounds in weight.

Operation (March 21, 1910).—Ether anaesthesia, elastic constriction, thorough curettage of lower end of tibia with removal of what appeared to be a large amount of red granulation tissue. The process had extended to, but had not involved, the ankle-joint, and was entirely limited to the tibia, although it appeared to have replaced all the bone with the exception of the thin shell adherent to the periosteum which it had caused to bulge. Patient was discharged from the hospital on June 5, 1910, entirely free from pain, with a movable ankle, no diminution in size of swelling and a small discharging sinus. March 7, 1911, readmitted because of local recurrence. Sinus present, admitting probe two inches. On outer edge of sinus tissue heaped up in a mass which somewhat resembled a strawberry in size and appearance. No pain. Thorough curettage with excision of recurrence on edge of sinus. Swabbed with phenol and alcohol. Packed with iodoform gauze. Discharged April 16, 1911.

Readmitted September 11, 1911, because of reappearance about one month ago of strawberry-like growth on edge of sinus which had failed to entirely close. No pain. Operation September 15,

1911, curettage fully as thorough as at first operation. Cavity swabbed with phenol and alcohol.

Operation (October 28, 1911).—Indication recurrence at edge of sinus.

Operation (November 28, 1911).—Recurrence again appearing at lower edge of sinus, curettage repeated. On discharge, December 6, 1911, general health excellent, no pain, sinus persisting, no evidence of recurrence.

Between this time and his readmittance, January 4, 1915, over three years later, had been able to follow his occupation as barber. His general health had remained good. No pain in ankle, but a sinus had persisted, which discharged a small amount of thin pus, and during the past five months had been the seat of several rather profuse hemorrhages. Recently a recurrence of the growth had also presented itself at the outer edge of this sinus.

Operation (January 5, 1915).—Curettage. The growth has changed somewhat in its macroscopic characteristics. While the small mass at the edge of the sinus again resembles exuberant granulation tissue, the bone cavity is no longer filled with the characteristic red jelly-like material, but consists of several cystic compartments containing clear fluid. Motion in ankle-joint is still good. March 28, 1915, discharged with sinus still present, no pain on walking, no evidence of recurrence; has gained fifteen pounds in weight (Figs. 13 and 14).

Summary.—The clinical history, operative findings and microscopic appearance undoubtedly classify this case under the heading of chronic non-suppurative osteomyelitis (Barrie), synonyms, giant-cell sarcoma, myeloma, and giant-cell tumor (Bloodgood). Our primary object in reporting this case is to show, that while there has been a fairly active and very persistent tendency to local recurrence, metastases have not occurred, and the man after a period of eight and one-half years is still in excellent health without pain and able to do his work, which requires that he be on his feet the greater part of the day.

Of course the ultimate outcome of this case is problematic. Too short a time has elapsed since the last operation to venture an opinion. From the economic stand-point, it might have been better to amputate early. The patient, even after these repeated disappointments and much time spent in the hospital, is still desirous and hopeful of saving his leg, and will not consent to anything more radical than curettage.

At present there seems to be a great difference of opinion as to the safety of curettage in these cases. Why should this be so? For practically all other tumors, the operative treatment has been standardized.



FIG. 1 —Case I. Presenting histological picture of medullary giant-cell sarcoma. Note growth encroaching on right orbit; also healed incisions over left clavicle near sternoclavicular joint, over right clavicle near acromial end and over rib in right axilla, where tumor masses were curetted.

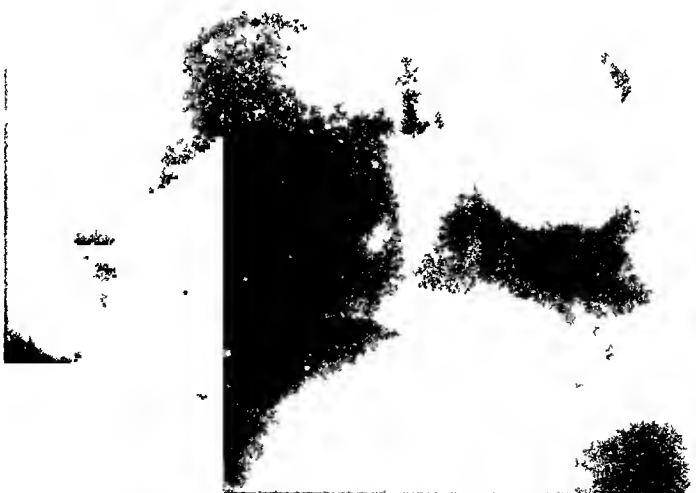


FIG. 2.—Case I. Röntgenogram showing tumor in right antrum.

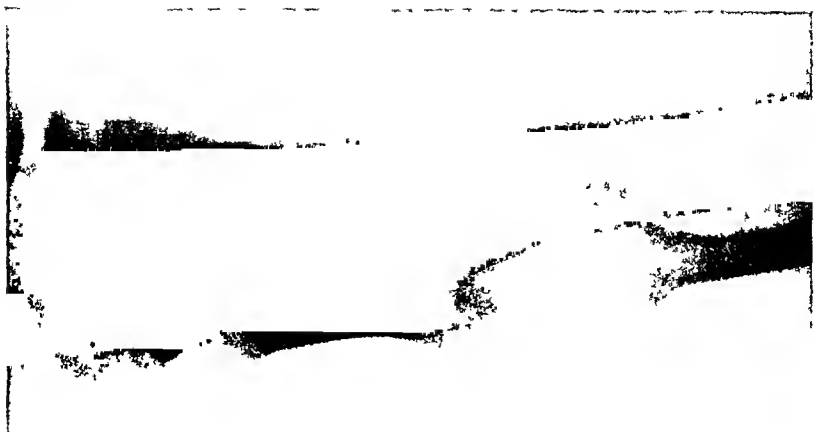


FIG. 5.—Case I. Röntgenogram showing tumor in right fibula.



FIG. 4.—Case I. Röntgenogram showing tumor in left fibula.



FIG. 3 —Case. I. Röntgenogram showing tumor in right femur.



FIG 6—Case I. Rontgenogram showing tumors in both clavicles

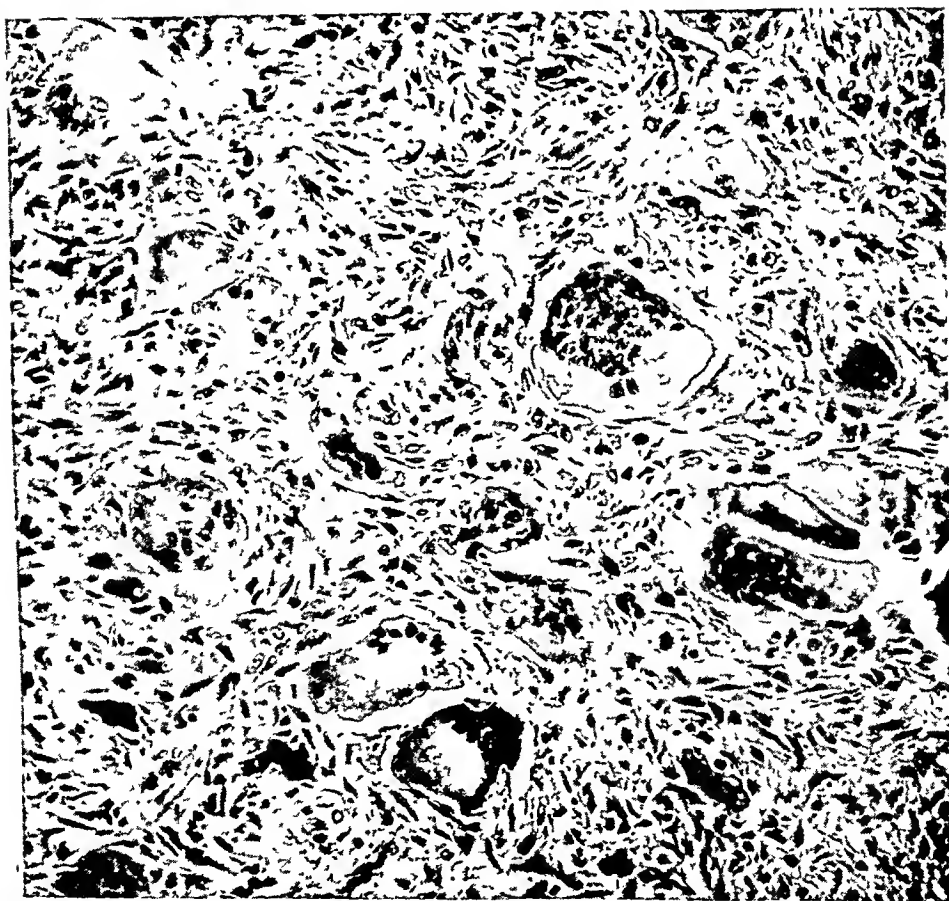


FIG. 7.—Case I. Showing numerous giant-cells of the osteoclast type and fibroblastic stroma. Note absence of mitosis in giant-cells and in stroma (low power).

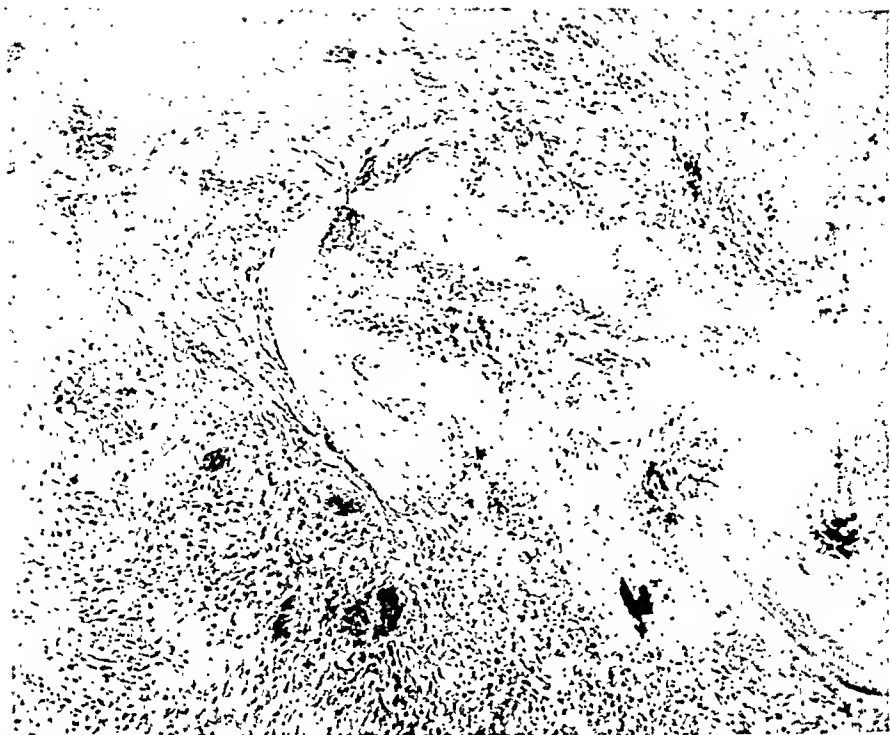


FIG. 8.—Case I. Showing giant-cells and fibroblastic tissue of stroma. Note erosion and disintegration of bone trabeculae (low power).

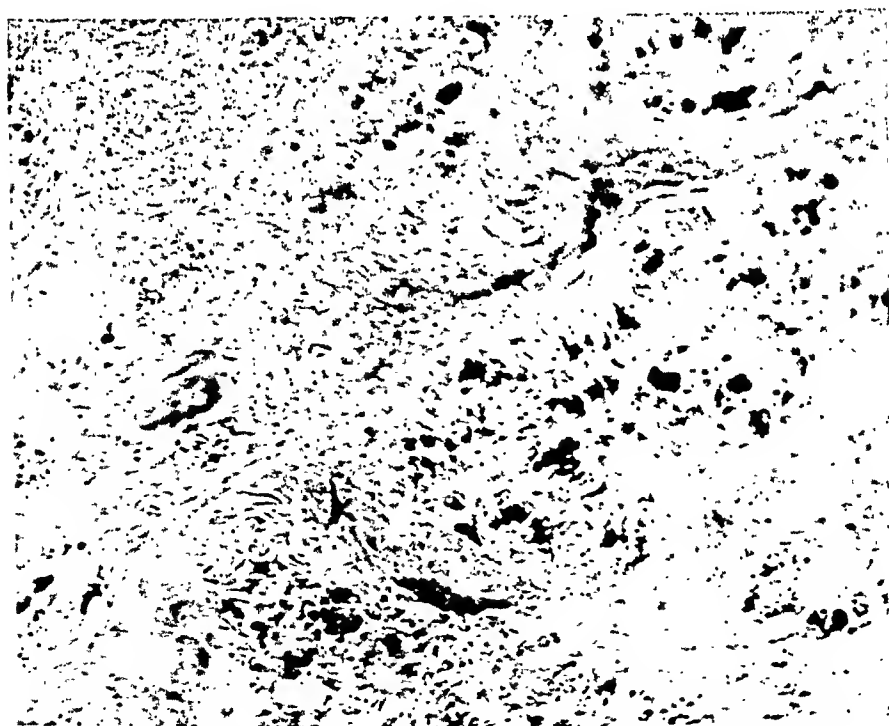


FIG. 9.—Case I. Showing giant-cells and fibroblastic stroma. Note hemorrhage in perivascular tissue and collections of blood pigment (low power).



FIG. 10.—Case I. Showing a giant-cell of the osteoclast type. Note numerous, regular in size and shape nuclei, with absence of mitosis, dark-staining, abundant cytoplasm with vacuolation. Note absence of mitosis in stroma (high power).

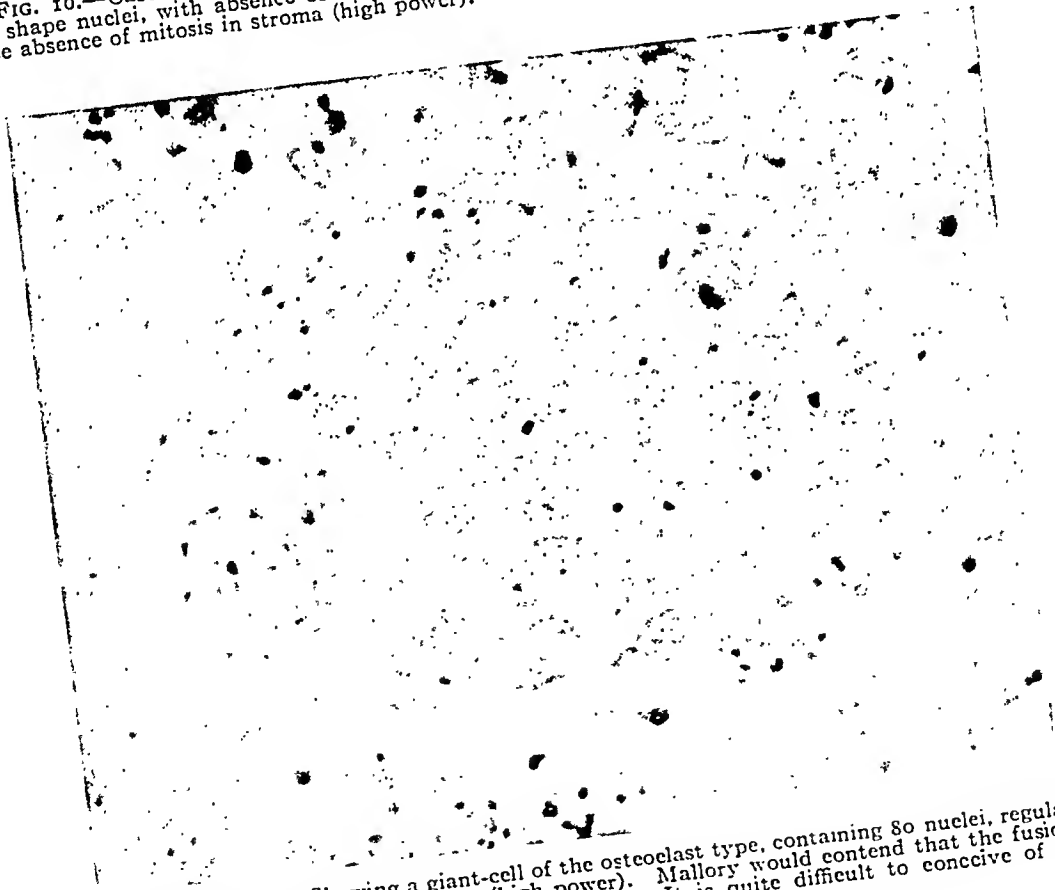


FIG. 11.—Case I. Showing a giant-cell of the osteoclast type, containing 80 nuclei, regular in size and shape, without active mitosis (high power). Mallory would contend that the fusion of endothelial leucocytes is responsible for such a cell. It is quite difficult to conceive of their origin in this manner.

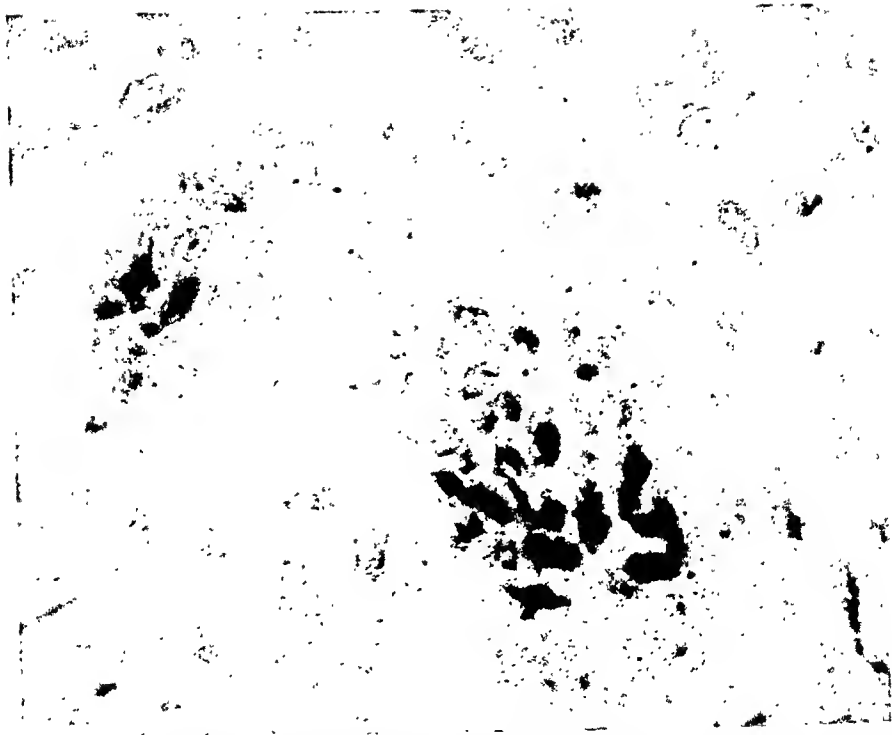


FIG. 12.—Case I. Showing two giant-cells of the osteoclast type, containing numerous nuclei, regular in shape and size (high power).

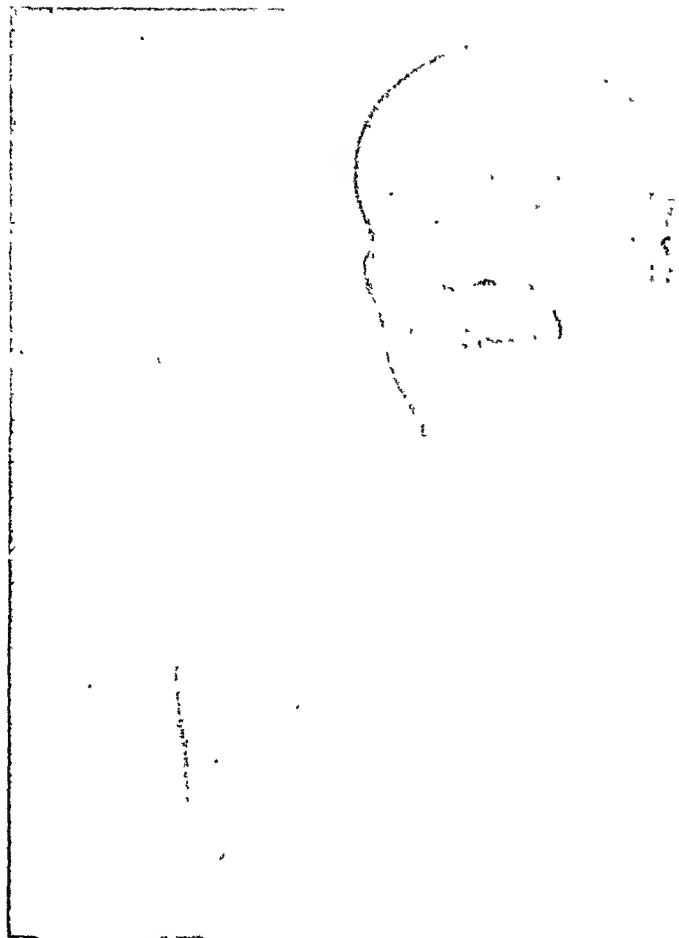


FIG. 13.—Case II. Note general health of patient is excellent, after eight years duration of tumor.



FIG. 14.—Case II. Showing appearance of leg eight years after onset of tumor. Note open sinus.
Recurrence is always on edge of sinus.

GIANT-CELL MEDULLARY BONE TUMORS

In making a fairly careful review of the literature, we have been impressed with the striking difference in the macroscopic appearance of the growths reported. For example, Connell² describes two cases in detail, one easily cured by curettage, and the other requiring secondary amputation. His macroscopic descriptions of the findings at operation in the two cases are so different that they immediately make one question their belonging in the same class. In describing the benign tumor, he says, "with a curette, a sponge full of what appeared to be granulation tissue was removed for microscopic examination." While his description of the more malignant growth is as follows: "division of the periosteum exposed the tumor which was distinctly localized and was composed of lobules of whitish-gray, cheesy material with bony trabeculæ extending from the periphery toward the centre."

The true hemorrhagic osteomyelitis (benign medullary giant-cell tumor) has a very characteristic appearance. In fact, it has not the appearance of a tumor at all, but rather that of exuberant, very vascular granulation tissue, filling the expanded bone, resembling somewhat red-currant jelly. Of course, in arriving at an opinion, a microscopic report is indispensable; still, practically all the giant-cell tumors which have proven to be benign have macroscopically had this appearance of red jelly-like granulation tissue.

Barrie¹ would classify benign bone cysts, osteitis fibrosa, chronic osteomyelitis fibrosa (Bloodgood), and traumatic solitary bone cyst under one term—chronic fibrocystic osteomyelitis, this being a later stage of chronic hemorrhagic osteomyelitis due to metaplasia. The findings at the last operation in the above case would seem to verify this contention.

PART III. PATHOLOGICAL SUMMARY

Sarcoma occurring in or near the ends of long bones, endosteal, medullary, or myeloid in character, presenting a macroscopic picture characterized by a tumor formation which is circumscribed, does not infiltrate soft parts, is distinctly vascular, friable, and resembles red granulation tissue; and a microscopic picture, composed of numerous giant-cells, with abundant dark staining and often vacuolated cytoplasm, numerous, regular nuclei with absence of mitotic figures; a stroma consisting of fibroblastic granulation tissue without active mitoses, dilated and engorged blood-vessels, hemorrhage in the perivascular tissue, and erosion and disintegration of bone trabeculæ, has been recognized for many years under such terms as medullary or myelogenous giant-cell sarcoma.

Bloodgood,³ in 1912, was the first in this country to seriously study the so-called medullary or myelogenous giant-cell bone tumors. He concluded that this type of tumor probably would never form metastases, but would recur *in loco* when not thoroughly removed; a fact that was recognized as early as 1895 by Koenig, Bergmann and Mikulicz. Bloodgood did not consider the tumor a sarcoma and for a more appropriate name termed it "medullary giant-cell tumor."

Adami,⁴ in 1910, would consider the so-called medullary or myelogenous giant-cell sarcoma as a type of myeloma, and would speak of it as "giant-celled myeloma." He recognizes the giant-cells in this tumor as myeloplaxes, he states: "Myeloplaxes differ from foreign body giant-cells in that the nuclei are distributed evenly through the cell body, and in the absence of central degeneration of that body, and from parenchymatous (true tumor) giant-cells in that the nuclei are well formed and of uniform size (lacking mitotic figures). They are present normally in the red marrow of bone, as osteoclasts in Howship's lacunæ, and are the characteristic constituent" of giant-celled myeloma where they are present in enormous numbers. He further states, "That the giant-celled myeloma has the following characteristics: it grows locally, most often in the shaft (marrow) of long bones, or of the jaw; it may be of periosteal origin (as in giant-celled epulis of the jaw); its growth is expansible, leading to absorption of the surrounding bones; it is abundantly vascularized; *it does not form metastases*; . . . it does not recur on complete removal; . . . it is only necessary to remove the portion immediately involved, with a very small surrounding zone; histologically, it exhibits a body formed mainly of short spindle-celled elements of fibroblastic type, somewhat irregular in shape, varying from the typical spindle to polygonal cells, and among these are abundant giant-cells of the myeloplaxe or osteoclast type."

Adami,⁴ in a foot-note, calls attention to Mallory's dissenting view as to the origin of the giant-cell encountered in these tumors, and of their importance in the tumor. He nevertheless considers them specific constituents of the tumor as much as the osteoclasts of Howship's lacunæ are specific parts of normal bone.

Mallory⁵ considers the giant-cells encountered in the so-called medullary or myelogenous sarcoma as "foreign body giant-cells, similar to the osteoclasts of normal bone," both of which he considers "are due to the fusion of endothelial leucocytes attracted into the tumor by the presence of lime salts which they dissolve and remove. They signify usually disintegration of bone, rarely the presence of fat and fat crystals. The tumor containing foreign body giant-cells should be classified

according to the nature of the other cells present in the tumor; the foreign body giant-cells should be disregarded. They do not signify either rapid growth or malignancy." He would attempt to make a diagnosis, by establishing the type cell in the tumor, and the malignancy of the tumor would depend on the presence or absence of mitosis in the stroma (for instance, benign or malignant fibroblastoma).

Barrie,¹ in 1913, called attention to the characteristic and microscopic appearances of the so-called medullary giant-cell sarcoma, forming a picture which is certainly entirely different from that encountered in malignant periosteal sarcoma or other malignant bone tumors. He believes that the process is not a tumor formation at all, but merely a chronic non-suppurating form of osteomyelitis, and has termed it "chronic non-suppurative hemorrhagic osteomyelitis."

It can be readily seen from the brief *résumé* of the opinions held by a few authorities, that it is quite impossible to correctly classify this tumor at the present time. Its correct interpretation is still a problem for future investigation. We are strongly of the opinion that Barrie's work remains the nearest approach to the proper interpretation of the lesion; although it would be still unwise to discard quickly the fact that the giant-cells found in these tumors may not be of bone-marrow origin and the tumor still belong in the myeloma class. Mallory certainly has not proven to our satisfaction that the enormous number of giant-cells encountered, with their regular and numerous (50 to 80) nuclei, can be explained by the fusion of endothelial leucocytes. The condition of the stroma in our opinion is much in favor of an inflammatory process, rather than a new-growth, and is the greatest argument in favor of Barrie's interpretation of the lesion.

Complex and as unsatisfactory as the scientific classification of this tumor is, there remains one important fact upon which most authorities have agreed, namely, that the giant-celled myelogenous or medullary sarcoma is not a malignant tumor. It does not produce metastases. While proper classification of all tumors should be the aim of pathologists, it frequently is quite difficult, and is often of secondary value; the real vital question to determine is whether a growth shall be considered benign or malignant. Adami, Bloodgood, Ewing, Barrie and numerous others, including ourselves, consider this tumor as benign.

Coley, we take it, from a review of his writings on sarcoma of the long bones,⁶ and from his discussion of our cases at the New York Pathological Society in November, 1915, claims that the differentiation between malignant and benign medullary bone tumors often cannot be

made, either from their gross appearance at operation or from their microscopic picture when studied later. We are not of this opinion.

From our experience with these bone tumors, we would express our conclusions as follows:

(1) That medullary giant-cell sarcoma, myelogenous giant-cell sarcoma, myeloma, medullary giant-cell tumor (Bloodgood), and chronic hemorrhagic osteomyelitis (Barrie), are synonyms for a bone lesion usually occurring in or near the ends of long bones.

(2) That this bone tumor has a typical macroscopic picture, a typical picture in the gross that is absolutely characteristic; and if the surgeon is acquainted with this picture, he can almost always at operation distinguish these tumors from malignant periosteal sarcoma or other malignant bone tumors. The typical gross appearance referred to is that of an expansive, well-circumscribed, non-infiltrating bone tumor which is usually confined within the periosteum; on breaking through the bone shell the tumor proper is composed of reddish, young, granulation tissue, which has been described as resembling red-currant jelly, fresh cut liver, schmierkase and red bar-le-duc.² This tissue is soft, friable and very vascular, causing considerable bleeding. There are frequently seen small whitish bodies varying in size from that of a grape seed to a pea (areas of osteitis fibrosa), and small cystic cavities. Both of these are evidence of metaplasia, and if at all active may convert the lesion, by fibrous replacement of the granulation tissue and retraction with consequent cyst formation, into the chronic fibrocystic osteomyelitis of Barrie—synonyms, benign bone cyst, osteitis fibrosa, chronic osteomyelitis fibrosa—cystic or solid (Bloodgood), traumatic solitary bone cysts (Felten and Stolzenberg).

(3) That the pathological histology is absolutely characteristic and that there is usually no difficulty for any trained pathologist to readily distinguish it from other malignant bone growths. The typical histologic picture referred to is characterized by the presence of numerous giant-cells of the osteoclast type. These cells have an abundant, dark staining, often vacuolated cytoplasm and contain numerous nuclei (20 to 70 or more) which are regular in size and shape, vesicular, and show an absence of mitotic figures and deep nuclear staining. The stroma consists of young fibroblastic granulation tissue without active mitosis, dilated and engorged blood-vessels, hemorrhage in perivascular tissue and erosion and disintegration of bone trabeculae.

(4) That the lesion is a benign one: *it will never form metastases*; amputation is therefore seldom indicated. Amputations in general for bone sarcoma are of very limited use, as periosteal sarcoma, practically

the only malignant form of primary bone tumor, has seldom been saved even by early amputation. There have been a few cases in literature of so-called giant-cell sarcoma supposed to present the above typical gross and microscopic appearances that have caused the death of the patient from metastasis. Mitchell Henry's case,⁷ 1858, is too ancient and the picture too poor to draw any accurate conclusions. Coley's case⁸ started as an ossifying myositis, and its histological appearance has been doubted by Bloodgood. Bloodgood says,⁹ "Every now and then . . . I have been informed of a case of giant-cell sarcoma in which the patient dies of metastasis. Some of these tumors I have been able to investigate and have found that the tumors were not giant-cell, but the most malignant sarcoma of the cellular type containing some giant-cells, and that, when the metastatic tumors have been examined, there were no giant-cells."

(5) The macroscopic and microscopic appearances encountered in Case I (the case presenting multiple bone tumors) are identical with that seen in Case II (the single bone tumor case); in fact, microscopic slides of each case cannot be told apart. It is therefore unnecessary to describe the multiple case in more detail, except to state that in every respect it seems to resemble the single lesion.

We believe, therefore, that the multiple case represents a clinical and pathological entity never described before in literature, that it presents the characteristic gross and microscopic appearances encountered in the single lesion, that it is not malignant, as it will always remain confined to the bones and will not form metastases. It should be classified therefore according to the classification of the single lesion, namely, as a multiple form of non-suppurative chronic hemorrhagic osteomyelitis; or if the single lesion is a form, namely, myeloma, as Adami thinks, it would be a new histologic form of multiple giant-celled myeloma, or a new form of multiple myeloma.

REFERENCES

- ¹ Barrie, George: ANN. SURG., Phila., lvii; Surg., Gynec. and Obst., 1914, xix.
- ² Connell, F. Gregory: Surg., Gynec. and Obst., 1915, xx.
- ³ Bloodgood, J. C.: Tr. Am. Surg. Assn., 1912, p. 503. Progressive Medicine, December, 1913.
- ⁴ Adami, J. George: The Principles of Pathology, 1910, vol. i.
- ⁵ Mallory, F. B.: The Principle of Pathologic Histology. Philadelphia, 1914, W. B. Saunders & Co.
- ⁶ Coley, Wm. B.: Tr. Am. Surg. Assoc., 1912, p. 506; ANNALS OF SURGERY. Phila., March, 1913.
- ⁷ Cathcart: Tumors, Innocent and Malignant, 1907, p. 35.
- ⁸ Coley, Wm. B.: ANN. SURG., Phila., March, 1913.
- ⁹ Bloodgood, J.: Progressive Medicine, December, 1913.

THE TRANSPLANTATION OF BONE IN UNUNITED FRACTURES OF THE SHAFT OF THE HUMERUS*

BY MELVIN S. HENDERSON, M.D.

MAYO CLINIC, ROCHESTER, MINN.

A FRACTURE through the shaft of the humerus is occasionally quite troublesome to handle. The patient is able to be about, which makes adequate fixation of the fracture difficult; this is the chief cause of the occasional non-union.

The records of the Boston City Hospital from May 24, 1864, to December 31, 1905, showed a total of 38,627 fractures. There were 3517 fractures of the humerus in this number, *i.e.*, fractures of the humerus formed 10.16 per cent. of the total. The radius was the only bone which was fractured more frequently.

The technic developed in treating ten cases of ununited fractures of the shaft of the humerus by transplantation of bone seems worthy of presentation. I shall not consider recent fractures. The operation itself is only a part of the treatment; the result which should follow an operation properly performed as to mechanical principles and technic is not obtained if the after-care and retentive splint are omitted. The spica type of plaster-of-Paris case is the most effective fixation for these fractures and can be worn comfortably for months if necessary.

Non-union of any bone is, comparatively speaking, very rare. I mean if the word "non-union" is limited to those fractures in which there is no evidence of union, after the lapse of the normal period of bone repair. In the Mayo Clinic the tibia, more often than any other bone, has been operated on for delayed union. If some months can be saved for the patient by such a simple procedure as that of the sliding inlay transplant,¹ when the facts have been presented, he will usually select the operation.

Just when "delayed union" becomes "non-union" is more or less arbitrary, and depends largely on the attitude of the surgeon. Statistics cannot be compiled when the personal equation enters so prominently into the consideration. On examining our records, it would seem as though a pseudo-arthritis occurred more often in the humerus and femur than in any other bones. This condition undoubtedly would be present in many of the tibias but for the fact that the fibula is usually

* Submitted for publication December 8, 1915.

UNUNITED FRACTURES OF THE SHAFT OF THE HUMERUS

intact or, if fractured, will have united, preventing the free mobility necessary to establish a false joint. In cases where both the fibula and the tibia were ununited there was a typical flail or false joint.

Hamilton ² has stated that non-union results more often after fractures of the shaft of the humerus than after fractures of the shaft of any other bone, due to the inadequate fixation provided both at the primary setting and during the convalescent period. Because we have operated on and observed more cases of delayed union in the tibia, does not prove that they are the most common. Many of the tibias that were operated on would undoubtedly have united after more protracted conservative measures. Usually the transplantation of bone was advised and undertaken merely as a means of saving time, which is so important to patients in the active period of life.

The cases used as a basis for this report were all old fractures, and in all the primary setting of the fracture had been done elsewhere. We have as yet to see a case of non-union in the shaft of a long bone which has been treated in our clinic from the time of the fracture. This is the experience of most surgeons, and emphasizes the fact that with the possible exception of intracapsular fractures of the neck of the femur, cases of non-union are rare. The use of metal plates, wire, etc., has practically been abandoned in our clinic, and for all delayed and ununited fractures, bone is transplanted.

Two distinct methods are used, one in which the bone is used as an intramedullary plug (Murphy ³), and the other, the inlay method (Albee ⁴). Both methods have their merits but the inlay appeals to one as being the more surgical procedure. It is now used in nearly all our work. The chief difficulty in handling these fractures of the humerus is to maintain adequate fixation after the bone transplant has been inserted. To put in the transplant and afterward put on a poor retentive apparatus is a useless procedure in the majority of cases.

Some of these patients present themselves with musculospiral paralysis. It is impossible to know in what percentage of fractures of the humerus this condition is present. Von Bruns ⁵ says that in 73 cases of fractures of the humerus there was musculospiral paralysis in 8.4 per cent.

Of our 10 patients there were three with musculospiral paralysis at the time of our examination. The nerve was traced in two of these and the fibres were apparently intact. In another case, paralysis of the musculospiral nerve was produced by excessive manipulation and traction at the time of the operation. We knew the nerve had not been severed and a good prognosis was given, but it was 4 months before

there was any return of power and more than a year from the time of operation before complete function was restored.

Technic.—A few days before the operation a spica plaster-of-Paris cast is applied to the shoulder and arm of the fractured side. This gives as near perfect fixation as it is possible to obtain; the cast embracing the wrist, elbow, shoulder and thorax. Before putting on this case, a dressing is placed on the arm about the size necessary to protect the wound after operation. During the application the wrist is held in mild hyperextension so that it will be retained in this position, the extensor muscles of the forearm being thus relaxed and not stretched. The elbow is put up in the flexed position with the arm rotated inward so that the forearm rests across the front of the body (Fig. 1). If there has been trauma to the musculospiral nerve and consequent paralysis, the muscles will regain their power more quickly on the restoration of a path for nerve impulses, than if the muscles are allowed to remain stretched. After the plaster has hardened sufficiently to allow cutting with a sharp knife, the cast is split into anterior and posterior halves which can be readily applied and held in place by adhesive strips after the operation is completed. This method is resorted to, since it is rather difficult to apply a good plaster spica to the shoulder with the patient asleep. Fig. 1 shows a cast which was applied two weeks after operation, and was worn by the patient for four months.

An inlay graft, as being more anatomical, is to be preferred. The sliding method is not practical, since in order to obtain a piece large enough very good exposure is necessary and consequent trauma is produced to the muscles and nerves. The graft is obtained from the flat internal surface of one of the tibias, preferably by the circular motor-propelled saw. It should be long enough to extend well into the sound bone of the ends of the shaft. A graft 6 inches long by $\frac{1}{2}$ of an inch wide is the ordinary size desired. A transplant that is too small causes more failures than any other one factor in bone grafting operations. The failures in our cases may be traced to two causes, too small a graft and inadequate fixation post-operatively and during convalescence. To hold the graft in the trough prepared for it double strands of number 2 chromic catgut or single strands of kangaroo tendon are used, placing them around the humerus by aid of a ligature carrier. The wound is closed with silkworm and horse-hair. The patient is placed in the split spica cast, which is strapped together with adhesive plaster. At the end of two weeks the stitches are removed and a new plaster-of-Paris cast applied. An opening is left over the wound if it is necessary to use further dressings. A brief history of each case is given herewith.

UNUNITED FRACTURES OF THE SHAFT OF THE HUMERUS

CASE I (70556. X-ray 16295).—J. R. B., male, aged twenty-eight, examined by us July 13, 1912. One year prior to examination, at which time there was no union, a fracture had been sustained of the middle third of the left humerus. The operation was performed July 17, 1912, and a three-inch plug inserted by the intramedullary method. A Lane plate and a retentive splint, merely extending from the elbow to the shoulder, were used. At the end of one year there was no union. On October 23, 1913, a second operation was done, the Lane plate removed, an inlay graft inserted, and a plaster-of-Paris spica applied. A mild infection occurred and persisted until December, 1914, when the transplant was removed at the patient's home. Union was firm at this time and the discharge from the sinus ceased within five days.

Following the first operation a musculospiral paralysis developed, due to excessive traction at operation. Since it was certain that the nerve had not been severed, a good prognosis was given, but it was four months before there was any return of power and one year before there was complete restoration.

CASE II (50611. X-ray 11299).—R. W., male, aged sixty, was examined on March 24, 1911, four months after the fracture had occurred. There was no union at this time. Lane's plate and an ivory intramedullary plug (C. H. Mayo⁶) were used with resulting non-union and infection. December 28, 1912, the metal plate and screws were removed and a bone plug inserted in the medulla in spite of a chronic low grade infection. Later the bone plug was thrown out because of the infection, and the patient lost sight of. At this time union was firmer than at any previous time. This history calls attention to the fact that a patient sixty years of age is not a particularly suitable case for bone transplantation.

CASE III (90547).—H. L. B., male, aged forty-six years, examined August 22, 1913. Eight months previously he had sustained a compound fracture of the humerus and the elbow became ankylosed. August 25, 1913, an intramedullary bone plug was introduced. The transplant broke in two months, the result of poor fixation. No plaster-of-Paris spica was used, and the ankylosed elbow in the extended position made it very difficult to control the arm. This patient has not been traced.

CASE IV (89929).—G. A., male, aged fifty-nine years, examined August 13, 1913. He had non-union of the lower third of the right humerus of 2 months' duration. There had been a compound fracture of the humerus, followed by marked limitation of motion in the right elbow. September 2, 1913, an intramedullary plug was inserted. The plaster-of-Paris spica was not used and the fixation was faulty. A stiff elbow complicated our efforts to control. November 27, 1915, the patient reported that there was no union. The poor fixation and the patient's age were prob-

ably responsible for the failure. Röntgenogram showed that the transplant had absorbed.

CASE V (92214).—I. B., female, aged eighteen years, examined September 17, 1913. Fracture of the lower third of the left humerus. Ten weeks after the fracture there was no union demonstrable. October 10, 1913, a bone plug was inserted, as an inlay in the upper fragment, and in the medullary cavity of the lower fragment. A plaster-of-Paris spica cast was used and firm union resulted in 3 months.

CASE VI (96248).—J. M., male, aged forty years, examined November 29, 1913. Ununited fracture of the middle third of the right humerus of thirteen and a half years' duration. All this time the arm had been used, the patient being a laborer. The röntgenogram (Fig. 2) shows the bone to be of normal density and not thinned out as are most of the fragments in ununited fractures. A typical flail-joint was present. The man came for consultation because of a musculospiral paralysis, which had been partial for five months, and complete for three months. He was operated on December 4, 1913, by a combined intramedullary and inlay method. One-half of the transplant was used as a plug and the other half was placed as an inlay in a trough prepared for it. The normal density and properties of the fragments warranted the use of a short graft. The musculospiral nerve was not traced or touched as it was thought the paralysis was due to the irritation produced by the rubbing of the fragments. There was no callus present to cause definite pressure. A plaster-of-Paris spica was applied and in 3 months there was firm union (Fig. 3) with full function of the musculospiral nerve. In four months from the time of the operation union was firm and the man was handling heavy timber in a lumber yard (Fig. 3).

CASE VII (101653).—M. H., male, aged thirty-eight years, examined March 4, 1914. Ten months before being operated on at the Mayo Clinic, this patient sustained a compound comminuted fracture of the lower third of the left humerus, followed by severe infection. At his home, after the wound had healed, metal plates were applied but non-union persisted. When examined by us March 4, 1914, four months after the plating operation, there was no union and marked restriction of motion of the elbow, possibly 10 degrees being permitted. Musculospiral paralysis was complete. March 12, 1914, we first forcibly flexed the elbow to about a right angle and then transplanted an inlay from the right tibia after removing the metal plates. The musculospiral nerve was not traced as it was thought that by securing union and reestablishing stability, the nerve would regain its function. The bone-graft used was only three and a half inches long and this accounts for the slow union (ten months). A longer graft would probably



FIG. 1.—Spica plaster-of-Paris case.



FIG. 2.—Non-union in humerus of thirteen and one-half years, duration. Note the normal density of the fragments.

FIG. 3.—Firm union three months after operation

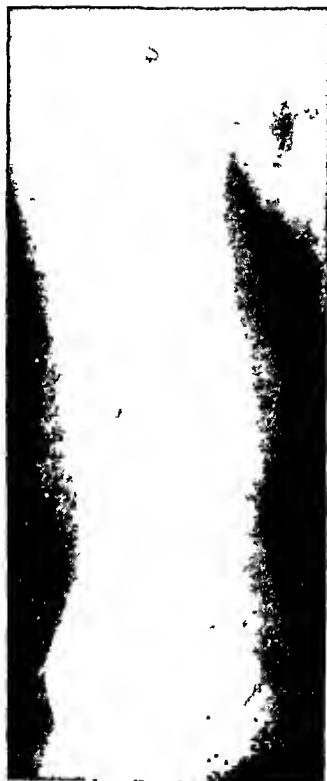


FIG. 4 —Non-union one year after wiring



FIG. 5 —Long inlay transplant extending well up into healthy bone. Union secured

UNUNITED FRACTURES OF THE SHAFT OF THE HUMERUS

have hastened the union. A plaster-of-Paris spica was applied. At the end of six months the union was apparently solid, but a plaster-of-Paris spica was worn for four months longer, when union was quite firm. Musculospiral paralysis persisted without noticeable gain and, on September 4, 1915, the nerve was explored and a separation found three inches above the elbow. The ends were freshened and sewed together with chromic catgut and silk, the anastomosis being surrounded with fascia obtained from the right thigh. An arthroplasty on the elbow will be done after the return of function to the nerve if no more motion returns in the interim. (Examination November 23, 1915, two months after operation, revealed no signs of return of function in the musculospiral.)

CASE VIII (104394).—J. H. F., male, aged fifty-three years, examined April 16, 1914, one year after having sustained a fracture of the right ankle and the right humerus. The fracture of the humerus was wired at his home, but, riding on a train six weeks later, which was wrecked, the right arm and right ankle were again injured. Following this musculospiral paralysis slowly came on. Four months later at his home the musculospiral nerve was traced and freed from all adhesions. At the time of our examination a fracture ununited in the middle one-third of the humerus (Fig. 4) was present and musculospiral paralysis was complete. On May 21, 1914, the fragments were exposed and the wire removed. An intramedullary plug was used and many bone chips placed about the site of the fracture. The bone transplant was not more than 3 inches in length. A plaster-of-Paris spica was applied. The musculospiral nerve was not traced. No union resulted although the cast was faithfully worn. On March 4, 1915, by the inlay method, we transplanted a piece of bone from the tibia 7 inches long (Fig. 5). August 27, 1915, his physician wrote that firm bony union had taken place. Musculospiral paralysis was still present.

CASE IX (119754).—C. B. W., male, aged thirty-six years, clerk, examined November 25, 1914. One and one-half years before he had fractured both tibias, both os calces and the right humerus. All the bones had united except the humerus, which was fractured in the lower third. This had been wired and plated at his home (3 operations), but no union resulted. December 5, 1914, the ends of bone were exposed and Lane plates removed. An intramedullary transplant was inserted and many small pieces of bone placed about the line of the fracture. A plaster-of-Paris spica was applied and worn for six months, but no union resulted. Again, May 5, 1915, he was operated on and the inlay method used. Two weeks after the operation, the split-cast was removed and a new one applied which was worn for five months, when union was found to be firm.

CASE X (107886).—L. R. H., male, aged thirty-three years, farmer, examined June 11, 1914. Two years before this man sustained a simple fracture of the left humerus; at 12 weeks there was no union, and in June, 1914, an intramedullary plug was put in by his home physician. No union resulted. On June 12, 1914, we applied a plaster-of-Paris spica, which was worn for 6 months, but no union was demonstrable on its removal. December 10, 1914, a large inlay graft was inserted and a plaster-of-Paris spica applied. Five months later firm union was demonstrable both clinically and by the röntgenogram.

Discussion.—In the treatment of these 10 cases a technic has been developed which if carefully carried out will give a high percentage of successes. That an exact technic is necessary is shown by the high percentage of failures which have occurred by the use of a small graft and a more or less haphazard after-care.

In 9 cases (excluding the case in which there had been non-union for thirteen and a half years) the average duration of non-union before transplantation of bone was twelve and a half months. The average age of the patients was forty-one years; the oldest sixty and the youngest eighteen years. But one woman (aged eighteen) was operated on. In 6 the right humerus was fractured, in 4 the left humerus. In 4 the fracture was in the lower one-third, in 6 it was in the middle one-third. Five had been operated on before coming to our clinic. There was an infection present in one at the time of the first operation and in another at the second operation. In four union was obtained by the first operation. In three a second operation was necessary. In two cases we were unable to obtain data as to the ultimate result; in one we know there has been no union; these two cannot be definitely reported upon except to say that so far as is known the results in our early cases were not satisfactory. They may or may not have ultimately attained union. Musculospiral paralysis was present in 3 at the time of our examination and operation. In one a short time before our examination and operation, the nerve had been traced and was said to be intact by the patient's home surgeon. Union of the bone had resulted from our operation, but now, more than one year afterward, there is no return of function in the musculospiral nerve and doubtless it should again be explored. One patient, a brakeman, had the paralysis at the time of the operation and we had intended tracing the nerve, but the implantation of the graft took so long, due to many adhesions and fibrous tissue caused by three previous operations, that no attempt was made to trace the nerve until some time later, when it was found severed. The ends were freshened and placed in a fascial tube made from the fascia lata of the thigh.

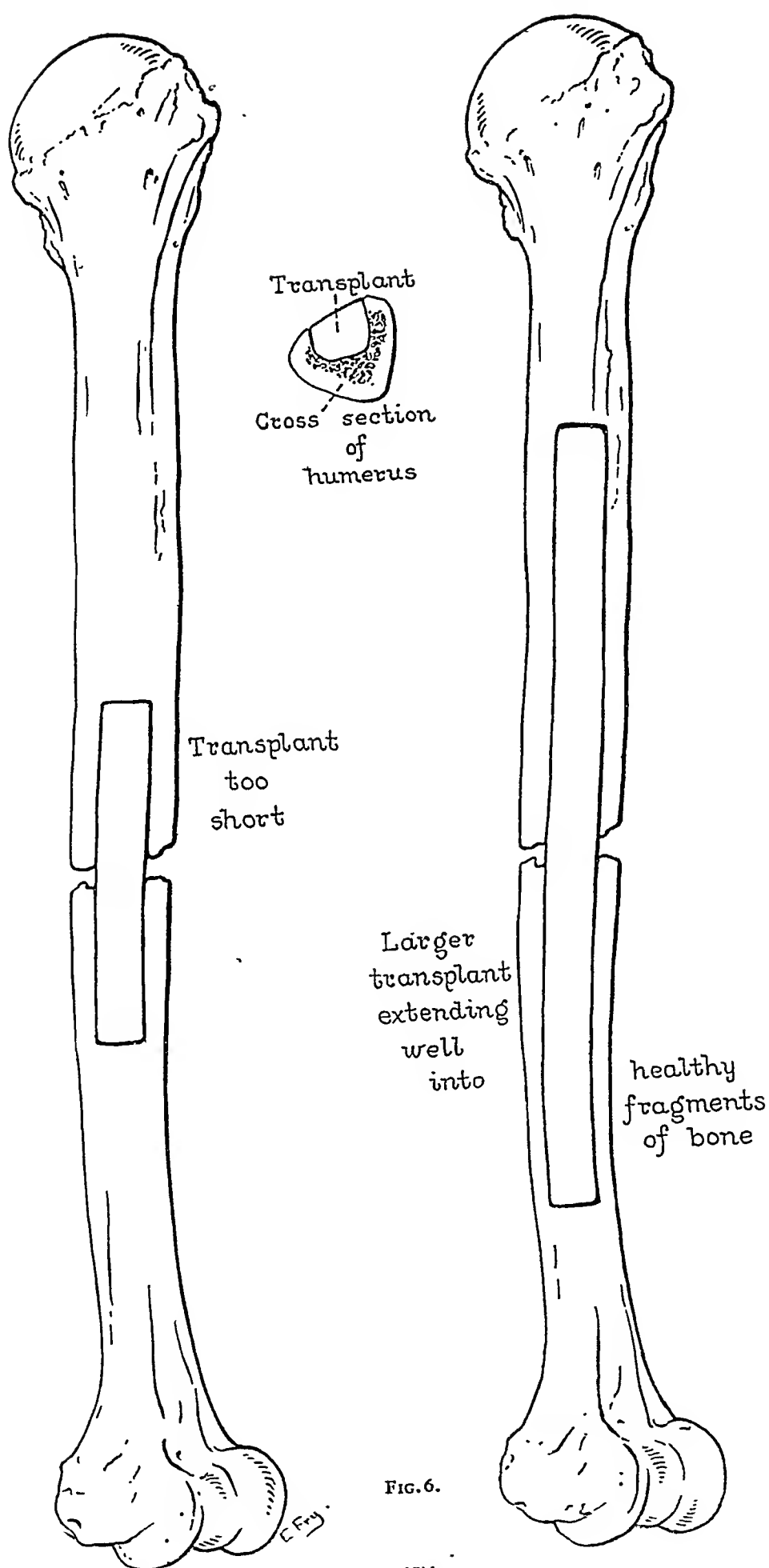


FIG. 6.

The result cannot yet be stated. In both of these cases the primary musculospiral paralysis was produced at the time fracture occurred. One case of ununited fracture of thirteen and a half years' duration had a secondary musculospiral paralysis. By the time the bone was completely united the function of the nerve was normal. In one of our early cases by too free and vigorous retraction at operation a paralysis of the musculospiral was produced which remained complete for four months and partial for one year. There is now full function in the arm.

CONCLUSIONS

1. The transplant must be as large as is practical (6 inches by $\frac{1}{2}$ inch or larger). It must extend well past the thinned decalcified ends into the hard, healthy bone beyond (Fig. 6).

2. The inlay is the method of choice.

3. Adequate post-operative fixation is essential. A split plaster-of-Paris spica prepared a few days before the operation can be fastened on with adhesive strips immediately after the operation is completed, thus eliminating the difficulty of applying the spica and the danger of disturbing the graft thereby. Two or three weeks later when the wound has healed and the stitches have been removed, a new cast can be applied carefully with the patient sitting up.

4. By removing the bone-graft from the flat internal surface of the tibia, the strong crest of the bone is left to perform its important weight-bearing function. The patient may be allowed to walk in from 12 to 14 days. At this time the blood clot filling in the bony defect has become sufficiently organized so that no hemorrhages will occur on the use of the leg.

5. A properly applied spica cast may be comfortably worn for 3 months, when in all probability union will be complete.

REFERENCES

- ¹ Henderson, M. S.: The Treatment of Ununited Fractures of the Tibia by the Transplantation of Bone. *ANN. OF SURG.*, 1914, lix, 486-499.
- ² Hamilton, F. H.: Fractures and Dislocations. Phila. Lea, 1891.
- ³ Murphy, J. B.: Contribution to the Surgery of Bones, Joints and Tendons. *J. Am. Med. Assn.*, 1912, lviii, 985, 1094, 1178, 1254, 1345, 1428, 1660.
- ⁴ Albee, F. H.: The Inlay Bone-Graft as a Treatment of Ununited Fractures; a Report of Fifteen Successful Cases. *Amer. Jour. Med. Sc.*, 1914, xxviii, 21.
- ⁵ v. Bruns: Die allgemeine Lehre von den Knochenbrüchen. *Deutsche Chir.*, xxvii. Quoted by Els, H.: Über Neurolyse bei Radialisparen. *Beit. zur klin. Chir.*, 1910, xlviii, 394-416.
- ⁶ Mayo, C. H.: The Present Status of the Treatment of Fractures. *Railway Surg. Jour.*, 1911-1912, xviii, 400-410.

OSTEOMYELITIS INVOLVING THE HIP-JOINT *

A CONDITION HERETOFORE ERRONEOUSLY DESIGNATED ACUTE EPIPHYSITIS

By JAMES E. MOORE, M.D.

OF MINNEAPOLIS, MINN.

PROFESSOR OF SURGERY IN THE UNIVERSITY OF MINNESOTA

"ACUTE suppurative inflammations affecting the joints of young children are grouped under the following titles: Acute suppurative arthritis of infants; epiphysitis; acute osteitis of growing bones.

"An acute suppurative synovitis occurs in children under four years, which Krause has found to be due to the presence of streptococcus pyogenes. It may be excited by injury or it may occur with the exanthemata. It gives the symptoms of a phlegmon, and usually yields promptly to free incision and drainage. It attacks the hip-, knee-, shoulder-, and elbow-joint.

"There is another disease usually placed under this heading that is of a graver character than the above-described disease, and which begins at or near the epiphyseal line. It occurs in the hip-joint, and has been well described by Macnamara under the name 'epiphysitis.' *It is an acute osteomyelitis.* The symptoms all point toward an acute inflammation of the hip-joint. There is excruciating pain and high temperature, followed by deformity and swelling. The joint is so deep-seated that redness does not occur. The symptoms are much more acute than in tubercular osteitis of the hip. There is apt to be an early separation of the epiphysis, with rapid destruction of the hip-joint. The treatment consists of free incision and drainage. The opening should be made large enough to admit a finger, in order to ascertain whether the epiphysis is separated or not. If separation has taken place, the epiphysis should be removed at once. This is a grave disease, but with prompt treatment the writer has seen cases recover that were seemingly beyond help."

This description was published by the writer eighteen years ago, and is just as good now as it was then. It should be observed that at that time the writer did not accept the commonly accepted term "epiphysitis" but pronounced it an acute osteomyelitis. Constant observation since that time has only confirmed the opinion then expressed; that this disease does not begin in the epiphysis but does begin

* Read before the Western Surgical Association, December 17, 1915.

in the neck of the femur, and one case cited goes to prove that it may even begin in the shaft of the femur. The epiphysis is the favorite site for attack by the tubercle bacillus, but there is no evidence whatever that this is ever the original point of infection from pyogenic germs. The reason the name "epiphysitis," originally suggested by Macnamara over twenty-five years ago, has been and still is in vogue is that osteomyelitis is quite rare in this location and the diagnosis is not made until the joint has become involved and the epiphysis has separated from the neck. The epiphysial line is the point of least resistance and soon gives way and the epiphysis becomes separated. When the joint is opened the floating epiphysis at once attracts the operator's attention and the original opening into the neck of the femur can be easily overlooked. Some reported cases of extremely rapid recovery after excision of the hip for tuberculosis have not been tuberculosis, but have been cases of osteomyelitis with separation of the epiphysis. Unfortunately, the infection in these cases is usually so severe that unless drainage is promptly established the patient loses his life; but in the exceptional case the infection is less virulent and nature may establish drainage by rupturing the abscess through the skin. The separated epiphysis acts as a foreign body and sinuses remain open. Deformity takes place, and the case assumes the appearance of the common tubercular hip, so that it may not be possible to make a differential diagnosis until an operation has been performed and a careful bacteriologic examination has been made.

Of the many cases of osteomyelitis involving the hip-joint seen by the writer, only four will be presented as proof of the correctness of the statements made in this paper.

CASE I.—A boy six years of age was admitted to the University Hospital with a very high temperature and in a semicomatose condition. His right limb was everted and the thigh very much swollen. The attending physician stated that the trouble began a few days before his admission, with high fever and very severe pain in the hip. A diagnosis of acute osteomyelitis was made and an incision made on the outer aspect of the thigh, as the boy's condition precluded any radical procedures at that time. Drainage was very profuse and rapid improvement followed, so that in a few days the patient was anesthetized and the original opening enlarged. By means of this opening a finger could be passed through an opening in the lower wall of the capsule of the hip-joint. The joint was then opened. The epiphysis was found separated and the whole neck of the femur destroyed,

so that it was necessary to make a formal resection of the hip-joint, after which improvement was rapid. The epiphysis was not much eroded, but the neck of the femur was broken down and necrotic, showing that the latter was undoubtedly the original seat of infection.

CASE II.—H. M., age nine years, was admitted to the University Hospital August 4, 1915, under a diagnosis of acute articular rheumatism. Gives a history of having had a fall one month before admission, from which she suffered very little. Two weeks before admission began to have pain in the joints, was nauseated and vomited. Since that had repeated chills. Most of the pain was in the upper part of the left femur. She gave the appearance of being profoundly septic. She was first admitted to the Department of Pediatrics, where it was found she was suffering from an empyema of the left side, and an abscess just below the left breast. She was transferred to the surgical service on August 7, when she was found to have in addition to her empyema an osteomyelitis of the upper third of the left femur and some swelling of the left wrist, and an abscess in the anterior chest wall. A section of one rib was removed from the axillary line and drainage of the pleural cavity established. The abscess of the chest wall was drained. Very little anæsthetic was given, operation was performed in a very few minutes, and the patient seemed no worse for it. Her temperature dropped immediately, but she still was very ill, giving evidences of profound sepsis.

A definite focus in the upper third of the left femur could be located with very little difficulty from the periosteal tenderness. There was some swelling of the hip-joint, but with care the joint could be moved without giving pain. There was flexion of the hip-joint. It was impossible to determine which was the primary focus, the femur or the empyema, but very probably the former. Notwithstanding the drop in temperature her condition was so low that we did not dare give an anæsthetic for operation upon the femur. When she was admitted her temperature was $103\frac{1}{2}^{\circ}$, pulse 160. After the operation her temperature dropped immediately to normal; pulse remained at 130; leucocytes 27,000; polymorphonuclears 72 per cent. On August 16 she had a sudden effusion into the pericardium and died.

Skiagraphs had been taken and showed breaking in the periosteum of the left femur, but nothing more.

At postmortem a large quantity of bloody serum was found in the pericardium. The empyema was practically well. On opening the left thigh an abscess was found, beginning opposite the point where the focus had been located clinically, separating the

periosteum from the inner side of the femur, extending up to the under side of the joint where it perforated into the joint, and the joint was full of pus. The femur was split longitudinally, showing the epiphysis healthy, but the focus beginning in the medulla of the femur extending upward. Had this patient lived longer the epiphysis would undoubtedly have become separated, and this might have been pronounced a case of acute epiphysitis by a careless observer.

CASE III.—T. S., aged twelve years. Case No. 6594. Admitted to the University Hospital July 20, 1915.

Ten or twelve days before admission she complained of pain in the right hip and pelvis, with temperature from 100° to 104° , but could walk about. She was admitted with temperature of 100.9° and pulse of 126; leucocytes 22,000; polymorphonuclears 65 per cent. Patient had slight flexion of the right hip. Complained of some pain in hip, thigh and pelvis. There was slight swelling over the right hip-joint. The slightest motion in the joint caused intense pain. Pressure made directly over the joint from front and back elicited excruciating pain. There was no tenderness on pressure in the femur.

A diagnosis of acute osteomyelitis of the neck of the femur was made. The writer believed that this was a typical case with an early diagnosis and one well fitted for the demonstration of the correctness of his views. So he requested one of the junior staff to operate upon it exactly as he would upon an acute osteomyelitis in any other location. Dr. Strachauer opened the hip-joint from the front, found some serum in it, but it looked comparatively healthy. The neck of the bone was so soft that an instrument could readily be pushed into it. A small opening was drilled directly into the neck of the femur and a drainage tube introduced into this opening, and the capsule of the joint closed around it. There was no flow of pus following the opening into the bone, but from the subsequent history of the case no one can doubt that this was the original focus of infection. We all know that our most brilliant results from operations for osteomyelitis are in those cases in which the diagnosis and treatment have been so early that little or no pus has been formed, but in which the symptoms have been relieved by the operation.

The following day her temperature dropped to normal, and varied from that on between normal and $99\frac{1}{2}^{\circ}$, disappearing entirely in the course of a few days. The drainage tube was removed on the tenth day. On August 4 the wound was completely closed, the joint freely movable and free from pain. On August 16 she was up, walking on crutches. Pain was relieved

OSTEOMYELITIS INVOLVING THE HIP-JOINT

immediately after the operation, and she was sitting up in a chair on July 30. , Was first allowed to bear weight on the joint August 19. She was finally restored to health with a healthy, normal hip-joint.

The infection in this case was not so virulent as in the average case, which accounts for the small amount of destruction that had taken place when the diagnosis was made, but can anyone familiar with the ravages of osteomyelitis doubt what the result would have been had the case gone on without proper treatment? The diagnosis should have been easier had the infection been more virulent.

CASE IV.—This case illustrates the fact that inflammation of the neck of the femur may be secondary to osteomyelitis elsewhere, and that it may be subacute in character. A boy twelve years old was admitted into the University Hospital with a severe osteomyelitis of the left tibia, which was operated upon promptly, after which he began to improve rapidly. After a few days he began to complain of discomfort in the right hip. There was no decided rise of temperature and the pain was not severe. The symptoms were so slight that too little attention was given him until we noticed that the limb was everted and shortened. The joint was opened and found full of pus. The epiphysis was separated and the neck of the femur was necrotic, so that a formal resection of the hip was made, after which he made a speedy recovery.

It is only with an earnest desire to bring out the truth that this case is reported, for it is not very creditable to us. We should have made the diagnosis early and drilled into the neck of the femur and saved the boy's hip. Our only excuse is the remarkable mildness of all the symptoms.

It is very evident that when Macnamara suggested the name acute "epiphysitis" he meant the term to apply to the whole neck of the femur, but the universal application of the term epiphysis to that portion of the head of the hip beyond the epiphysial line has led to an unfortunate misunderstanding and much bad surgery. The term "epiphysitis" should therefore be abandoned. The name osteomyelitis as applied to pyogenic infection of the neck of the femur in this paper is incorrect, because the neck of the femur has no medulla, but is used by the writer to emphasize the fact that acute pyogenic infection of the neck of the femur in growing bone does occur, that it resembles osteomyelitis in every particular and that it demands the same prompt treatment. It is even a greater menace to human life than osteomyelitis, because it is more difficult to diagnosticate, and when the original seat

of infection breaks down the opening is into the hip-joint instead of the soft parts. These cases are not so rare but that they come under the observation of every surgeon, and they demand more careful consideration than they have received heretofore. They offer a field for brilliant, life-saving surgery. When the diagnosis is made very early, before the joint is involved, the operation originally suggested by Macnamara and later advocated by Huntington should be performed. An incision should be made over the great trochanter, and an opening drilled through the trochanter and the centre of the neck of the femur in its long axis until the seat of infection is reached. When the diagnosis is not made until the joint is involved it is better to enter the joint directly from the front. The only reason the Macnamara operation was not performed in Case III is that the diagnosis was questioned by some members of the staff and we wanted to see just what we were doing.

When the late operation is done a formal excision should not be made unless the neck is completely necrotic, but as much of the neck should be preserved as possible for future usefulness.

While the writer advocates the abandonment of the term "epiphysitis" he has no new name to offer. The term "acute suppurative arthritis" is objectionable because there are many cases of acute suppurative synovitis in which the bone is involved, and they are not nearly so serious. Would it not be well to revive the old term "acute osteitis of growing bone"?

THE LEGAL RESPONSIBILITY TO THE SURGEON AND PRACTITIONER WHICH THE USE OF THE X-RAY INVOLVES

BY ELLSWORTH ELIOT, JR., M.D.
OF NEW YORK CITY

IN December, 1912, an experienced surgeon was the defendant of a malpractice suit in which the plaintiff recovered a verdict of over \$11,000, on the ground that the care of a simple fracture of the lower part of the shaft of the femur, the result of an automobile accident, had not received due and proper attention. Four weeks after the accident the patient was seen in consultation by the writer, and, at a considerably later period, in fact after a plating operation by another surgeon, the patient was examined by the late Dr. Bristow. To us both, subsequently associated in the defence of the action in court, the importance of the case and the fact that such a verdict, if sustained on appeal, would make the physician or surgeon hesitate to undertake the treatment of cases of this character, seem to warrant the presentation of its chief surgical and legal features in the hope that this Association might take some action that would, in a measure at least, protect the surgeon in future from unwarrantable suits of this character.

For this task Dr. Bristow kindly volunteered and had prepared or was preparing a paper with the title already cited when his unexpected and most unfortunate death occurred.

The importance of the matter was such, however, that notwithstanding the short notice, the writer was impelled to take Dr. Bristow's place in order that the question might be presented to this Association for discussion without further delay.

The testimony showed that after the accident the patient was conveyed to the nearest suburban hospital in an ambulance, the fractured thigh having been placed in temporary splints; that, at the end of forty-eight hours after the shock had subsided, the fracture was reduced by the defendant under a general anæsthetic and placed in a Buck's extension apparatus; that, at the end of the fourth week, the writer found the fragments imbedded in abundant callus with no sign of either axial or angular deformity and with a shortening that did not exceed one-half an inch; that, near the end of the fifth week, the union being sufficiently advanced to permit of active rotation of the thigh, and no false point of motion being elicited, the leg was put in a plaster-of-Paris splint.

The patient was then gradually allowed out of bed on crutches with adequate support to the thigh and with strict injunctions to bear no weight on the affected side, a nurse being in constant attendance. At that time the shortening did not exceed one-half an inch.

From this time until her discharge from the hospital, nine weeks after the accident, the testimony was uneventful with the exception of one fact. At the eighth week the plaintiff declared that a slight slipping of the crutch caused her to lose her balance, and that, although the nurse prevented a fall, the patient involuntarily placed a slight amount of weight on the affected side. The resultant pain was so slight and of such short duration that the incident was not reported to the defendant by either the nurse or the patient. In addition, the testimony of the defendant showed that, contrary to this strict injunction, the patient, at about this same time, had made an effort to get out of bed unaided by the nurse and in her absence and had felt a severe pain at the point of fracture. It was on the following day when the defendant, on measuring the thigh, found a sudden increase in the shortening to almost one inch, that, in answer to his question, the patient reported the above incident. Notwithstanding this sudden increase in the shortening the surgeon found no false point of motion and concluded that there had been some displacement of the fragments without actual recurrence of the fracture. In the course of the trial the conversation above cited was indignantly denied by the plaintiff.

At the end of the ninth week and at her own urgent and oft-repeated request, the patient was discharged from the hospital and referred to her own family physician in New York, with strict injunction to bear no weight on the affected side until four weeks later or until the expiration of the thirteenth week after the accident.

The family physician testified that on several visits for minor ailments before the expiration of this time, he had examined the fractured thigh and had noticed some irregularity but no false point of motion. He also testified that he was present, when, three weeks after leaving the hospital, patient made an effort to bear the weight of the body on the affected side and experienced such terrible pain at the point of fracture that the experiment was not repeated. An X-ray, taken four weeks later or sixteen weeks after the accident had occurred, showed an old oblique fracture of the lower end of the shaft of the femur. The line of fracture made an angle of about 20 degrees with the shaft, and although in the anteroposterior plane the alignment was perfect, in the lateral plane the fragments appeared displaced to such an extent that the posterior aspect of the upper appeared to be in touch with the an-

terior aspect of the lower fragment. The fragments seemed firmly united with callus, there was no false point of motion, and the shortening did not exceed one inch.

Without the knowledge of the defendant a third surgeon saw the plaintiff in consultation four and one-half months after the accident and advised an operation in which the fragments were exposed, their ends freshened by the removal of five-eighths of an inch from each fragment and after alignment they were secured in the usual way by plates. An X-ray, after union had taken place, showed some angular deviation notwithstanding the plates which, in the opinion of the plaintiff's physician, accounted for at least one-quarter of an inch of the final shortening. At this stage the patient had been examined by Dr. Bristow, and his testimony as well as that of the plaintiff's physician showed that the final shortening did not exceed two inches.

The removal of five-eighths of an inch from either fragment together with the one-quarter of an inch additional shortening due to the final angular deviation proved conclusively that prior to the operation the shortening could not possibly have exceeded one inch.

It was further shown by the testimony that, three weeks after the accident, at the suggestion of the defendant, an effort was made to secure an X-ray with the hospital machine, but the result was unsatisfactory as the machine proved to be out of order, notwithstanding an attempt was made to put it in repair. It was also shown that several months would be required before the machine could have been placed in serviceable condition. The defendant was in no way held responsible for this failure as the machine was the property of the hospital.

No further attempt was therefore made to utilize the hospital apparatus and no suggestion was made by either the defendant or the plaintiff to call an X-ray expert from New York. It was in lieu of an X-ray that a consultation was suggested by the defendant and accepted by the plaintiff. In the course of the trial the medical testimony of the plaintiff admitted that the treatment, as conducted by the defendant, was a proper and recognized form of treatment and that the failure of the defendant to suggest the calling of an X-ray expert constituted the sole basis for the charge of neglect.

In his charge to the jury the judge called attention especially to the fact that the defendant had failed to suggest the taking of an X-ray, after the failure of the hospital apparatus, by a specialist from New York (35 miles distant), and, in the opinion of the defendant's counsel, it was the special prominence given this fact that led to the unfortunate verdict.

The first question suggested is as follows: With firm union between the fragments of a broken shaft of the femur and with a shortening of an inch or less, is an operation indicated because, on the first attempt to bear the weight of the body on the affected side, the patient experiences excruciating pain?

The question is easily answered. The opinion would, I am certain, be unanimous that more or less severe pain on the first attempt to bear the weight of the body on the affected side after a fracture of the shaft of the femur had firmly united, would not be unusual, especially in patients who had sustained or were still suffering from some severe mental shock, and that only the persistence of severe pain, unabated, after repeated attempts at walking would indicate operative interference. That displacement in itself is not a cause of pain nor a barrier to union is frequently demonstrated by patients in whom a shortening of three inches or even more from extensive overriding of the fragments has not prevented union sufficiently strong to bear without pain or other inconvenience than a limp the superimposed weight of the body. It must be generally conceded that any fracture of the shaft of the femur in which firm union takes place with permanent shortening not exceeding one inch is a satisfactory result and that instances in which some shortening is not observed are very rare. A moderate shortening in itself clearly indicates a corresponding overriding or displacement due to the failure to counteract, by the usual forms of extension and counter-extension, the stronger pull of the powerful muscles of the thigh. As a matter of fact, this difficulty has led to the devising of more efficient methods of powerful traction applied directly to the lower fragment itself as well as to the advocating by Lane and others of the plating of every fracture of the shaft of the femur where the general condition of the patient permits.

The question of negligence based on the failure of the attending physician or surgeon to suggest or advise the taking of an X-ray photograph in cases of simple fracture, presents a most interesting as well as a most important topic for discussion. It is peculiarly important in that, prior to the case reported in this paper, there has been no record in either medical or legal literature in which a plaintiff has been awarded damages on such an allegation. The question may be discussed most advantageously from the medical as well as from the legal point of view. The medical point of view is best approached by a brief résumé of the history of the X-ray. Shortly after its discovery some form of apparatus formed a part of the office equipment of many successful practitioners throughout the country. After a com-

paratively short time experience taught that the care, the development of its operative technic, and in short the intricate detail necessary to procure satisfactory results precluded its general use, and another specialty was born with the result that many costly X-ray machines in the possession of the busy practitioner were quickly consigned to the scrap heap.

Ranking from this time with the specialties, those engaged in it formed a group of which the functions were quite analogous to the functions of special consultants in other branches of medicine. Under such circumstances and with such functions their services in aiding the diagnosis and treatment of cases of fracture were essential only when the bone at the point of fracture was so deeply seated that accurate diagnosis was impossible, or, if diagnosis had been made, when the excessive thickening of the overlying soft parts made satisfactory reduction of the fragments difficult. Under the conditions the assistance of the röntgenologist became of great value. Is, then, the function of the X-ray specialist to be extended to those cases of fracture in which the attending surgeon, by methods of diagnosis and reduction evolved through centuries of observation and investigation, can be reasonably certain that the fragments are in such apposition that satisfactory union may be expected? The writer believes that this is no more essential than it is to call a special consultant in every case of pneumonia, appendicitis, or strangulated hernia. Is not, as a matter of fact, the consultant called more frequently at the request of the family than with any hope of benefit from his advice? And is it not with the same spirit, the spirit of self-protection, that, in cases of fracture or dislocation, an X-ray is suggested when the surgeon is morally certain that the fragments are in apposition or that the dislocation has been successfully reduced? Is not the fear of litigation in the event of non-union or other unfortunate result, in no way the fault of the surgeon, a very strong incentive for generally advising an X-ray irrespective of the location of the fracture? The writer believes that these questions must be answered affirmatively and that it is time to establish the principle that the use of the X-ray, although in many instances most desirable, yet in many cases is not indispensable to the proper treatment of a fracture. That such a principle should be established is all the more essential in view of the fact that, having become a specialty, the use of the X-ray is frequently inaccessible in many cases of fracture. Should any method of diagnosis or treatment be regarded as indispensable when it is not generally applicable? Should the physician in a scattered community, remote from an X-ray laboratory, be subject to litigation because he

fails to advise or suggest the need of an X-ray? This question is best answered by quoting the legal statute of the State of New York as follows:

"A physician is bound to have a reasonable degree of skill and learning, and having that reasonable degree of skill and learning, he is bound to exercise it with reasonable care, and what his reasonable care is, is that care which the ordinary careful and prudent practitioner usually ordinarily exercises in the locality in which the physician is practising."

In view of this statute the treatment accorded by the physician must be that ordinarily exercised in the community of which he forms a part. In almost no community outside of large cities are efficient X-ray machines found, and even in large cities the smaller hospitals are not always provided with adequate X-ray apparatus. In the community in which the alleged malpractice occurred no X-ray machine was in working order, but this fact did not prevent the judge from connecting this suburb, although 35 miles distant, with New York proper and thereby compelling the defendant to measure up, both in knowledge and in efficiency, to a standard which did not obtain in the community in which he lived.

Finally, is the physician or surgeon liable to damages because of his failure to advise a consultant? Irrespective of the nature of the disease or trauma and irrespective of the locality in which it occurred, how endless would be the resulting litigation if such omission constituted neglect. Whether the object of such a suggested consultation were to aid in diagnosis or whether to suggest a way to prolong the life of one hopelessly ill, the frequency of examples of such neglect would be beyond computation. The writer firmly believes that arrangements for consultation are made at the request or suggestion of either the surgeon or some member of the patient's family, and that in the latter event the fact that such a consultation was not deemed necessary and therefore not suggested by the surgeon can in no wise be construed as neglect.

Lack of time precludes the consideration of the many uncertainties connected with the interpretation of the X-ray picture itself. It is a well-known fact that on exploration a condition may be found essentially different from that which the X-ray seemed to indicate and, similarly, deformities may be either exaggerated or minimized by the manner in which the photograph is secured. Space also precludes the consideration more minutely of the question of the inaccessibility of the X-ray owing to the distance from large centres, and a most important fact, that even in large centres some hospitals are conducted without the

advantages of an X-ray apparatus, may not have been duly emphasized. Suffice it to say that after careful consideration of the many phases of the question, although in many instances a most important and valuable aid in the diagnosis and treatment of fractures, the use of the X-ray must not be judged indispensable, and the neglect to advise its use should in no instance constitute a basis for the recovery of damages. Should such a principle prevail the time is not far distant when the prospect of litigation will prevent those most competent from undertaking the care and treatment of cases of this character.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

Stated Meeting, held December 8, 1915

The President, DR. CHARLES N. DOWD, in the Chair

OPEN REDUCTION OF FRACTURED EXTERNAL CONDYLE OF HUMERUS

DR. WILLIAM DARRACH presented a boy, five years of age, who was brought to the Presbyterian Hospital on November 11, 1914, for an injury sustained one week previously. The elbow was slightly swollen, especially on its outer aspect, where a bony mass could be felt just beneath the skin. This mass was freely movable in an anteroposterior direction, but only slightly up and down. It was not tender and presented a flat subcutaneous surface. Extension was possible to 175° and flexion to 80°. Pronation and supination were normal. X-ray examination showed the fragment of bone to consist of the capitellar centre, the epiphysial line plus a thin shell of shaft.

On the following day a curved incision was made over the anterolateral aspect of the elbow and deepened through the fascia along the inner margin of the brachioradialis. The brachialis anticus was then split a little to the inner side of the musculospiral nerve and the lower end of the bone exposed. The fractured surface of the lower humerus presented but the fragment could not be located until a gauze-covered finger was introduced. The fragment was then found to the outer side but still within the joint and still attached to the structures inserting at the external epicondyle. The line of fracture had passed through this point downwards and inwards, reaching the joint line just within the outer trochlear margin. By pressure outside with the aid of the leverage action of an elevator, the fragment was finally pried into place. As the elbow was flexed, the radial head seemed to hold the fragment in good position and the wound was closed with catgut for the deeper tissues and silk for the skin. The elbow was immobilized at 60° with a starch bandage. His highest post-operative temperature was 100° and he left the hospital 9 days after operation. The boy developed chicken pox soon after leaving the hospital and was lost track of for a while. His motion returned rather slowly but at the end of a year he seems to have a normal elbow. The X-ray shows

FRACTURES OF THE NECK OF THE SCAPULA

the fragment in place and there is no apparent interference with the normal growth of the lower humerus.

OPEN REDUCTION OF FRACTURE OF THE CAPITELLUM

DR. WILLIAM DARRACH presented a man, thirty-five years of age, who on June 9, 1915, had slipped on a sidewalk and fallen first on his palm and then on his elbow. There was considerable pain referred to the front of the elbow, made worse by extension. Pronation and supination were a little limited and flexion was stopped at 80°. He entered Presbyterian Hospital and was operated on 6 days after his injury. With the elbow flexed to 90° an incision was made from a point a little above the external epicondyle downward and forward for a distance of three inches. The extensor aponeurosis was split and the joint cavity opened. The radial head and the fractured surface of the humerus presented. The capitellar fragment was located after some difficulty lying in front and above its normal site. It was removed, its broken surface wiped free of new-forming tissue, washed with hot saline and replaced in the normal site after the humeral surface had been freshened. The line of fracture had passed from above and in front, downward and backward, so that as the forearm was flexed to 90° the radial head seemed to hold the fragment in good position without any internal appliance. The deeper tissues were approximated with chromic gut, the fascia with plain gut and the skin with silk. The arm and forearm were dressed and the elbow immobilized at 90° with a plaster bandage. The wound was dressed on the sixth day and the stitches removed. Primary union. The plaster was removed after three weeks and motion started. The motion at the elbow gradually increased.

The X-ray taken three weeks after operation showed the fragment to be in perfect position. That taken 10 weeks after operation showed that the capitellum had rotated outward a little.

DR. HITZROT remarked upon the difficulty of determining the source of fragments split from the capitellum, especially in fractures of the head of the radius. Several years ago he presented before this society a young woman who had a fracture of the head of the radius. From the X-ray one could not determine that there was any injury to the capitellum, but at the operation there was found a fragment broken off from the capitellum which had become engaged in the fracture line in the head of the radius.

FRACTURES OF THE NECK OF THE SCAPULA

DR. JAMES MORLEY HITZROT read a paper with the above title, for which see page 215.

DR. ARPAD G. GERSTER recalled a case observed by him as long ago as in October, 1872. He fixed the date because it was a few weeks after he had entered upon his service as a military surgeon in Vienna.

The accident that led to this injury occurred in the School of Equitation which was not far from the barracks in which he was on duty and had quarters.

An officer was thrown by a bucking remount and landed on his shoulder. He was a very muscular and rather heavy young fellow. The slightest passive motion excited a tremendous muscular contraction around the shoulder and howls of pain. As crepitation was plainly felt, a fracture of the humerus was first thought of, but on rotation the head of the humerus could be distinctly felt moving with the shaft. Then, looking at the patient from behind it was seen that the injured elbow was much lower down than its uninjured mate. This was most noticeable when the musculature of the shoulder and the arm was relaxed. There was present also a deformity or a subcutaneous defect visible at the normal site of the acromion, as compared with its mate; that is, a depression of the left shoulder. Careful manipulation and collation of all the facts demonstrated that the acromion, the coracoid process, the glenoid fossa and humerus were down together. Evidently there was a fracture of the neck of the scapula. In those days there was no X-ray. Diagnosis was not then as easily controlled as it is to-day.

In this case the treatment consisted in the application of a Velpeau bandage. As soon as that was applied, the patient's pain was much relieved and he became comparatively comfortable, especially after a morphine injection.

Billroth, called in consultation, examined the patient and confirmed the diagnosis.

The patient got well, and the function of his shoulder-joint was almost entirely restored.

ACUTE OPERATIVE DILATATION OF THE STOMACH

DR. BURTON J. LEE reported the case, for which see page 421.

DR. JOHN ROGERS said that in a report of a similar case published in the *Journal of the American Medical Association* about a year ago, it was stated that while the stomach was exposed in the midline above the umbilicus, the surgeon saw the stomach distend; he enlarged the wound and followed the stomach into the pelvis, and noticed stomach distended with fluid. He washed the stomach out with the belly open and saw the stomach gradually contract and refill, and the patient eventually recovered.

ACUTE OPERATIVE DILATATION OF THE STOMACH

Dr. Rogers had always felt that ether had something to do with dilatation of the stomach. A year ago he operated upon an inguinal hernia under novocaine-adrenalin. It was a very simple case in a man of about fifty. He died of a dilatation of the stomach in about four days, verified by autopsy, and at that time the stomach was very much distended, with the small intestine also distended with fluid equally with the stomach, a brownish fluid which is quite characteristic of these cases.

There are several cases in literature in which a gastro-enterostomy has been done for acute dilatation of the stomach without the least benefit, and it cannot be said that anybody knows anything about the causation of the disease. The appearance strongly suggests something to do with osmosis in which there is a chemical disturbance in the blood. By exosmosis the fluid is poured out into the stomach and intestine, and there is such a vast amount of fluid that it is possible that they die of water starvation or of a concentration of some inorganic salt. Mechanical obstruction from the mesentery cannot, in his opinion, result in death.

DR. GERSTER said that in the absence of the pathologist's opinion regarding the actual cause of death, the forming of a theory is admissible.

The postmortem first demonstrated a very small heart and very small arteries. Now, then, that is a well-known cause of death after traumatism, but especially apt to occur after operations under anæsthesia. During the last year of his service at Mt. Sinai Hospital, he lost a patient, a young woman suffering from a small, free and stenosing cancer of the pylorus, from this combination of factors. A rapid and smooth resection was done followed by gastro-enterostomy. The whole operation did not take more than forty minutes and very little ether was used. Without premonition, the patient collapsed about thirty hours after the operation and died in syncope. Nothing could bring her back to life. Post-mortem inspection demonstrated the absence of hemorrhage or any other demonstrable complication. The heart and arteries were the size of those of a child of nine years.

Now, then, in Dr. Lee's case, there was hypoplasia and a rather prolonged operation, lasting an hour and thirty minutes. By this a great task was laid on that small heart and those small arteries. Second, there was found œdema of the lungs. These two facts taken together, with the anæsthesia, are sufficient to account for the death. He did not believe that the dilatation of the stomach alone, whether acute or chronic, could account for the death. Acute dilatation is of course a

grave factor interfering with the circulation, and may precipitate fatal syncope in the presence of cardiac insufficiency. Distention of the stomach would embarrass the action of lungs and heart and may thus bring on death. He would be inclined to accept these facts as an adequate cause of death: long anæsthesia, operative traumatism, a small and weak heart, small arteries; finally œdema of the lungs, perhaps due to insufficiency of the heart.

DR. ALEXIS V. MOSCHCOWITZ said that about seven years ago he operated for a bilateral inguinal hernia on a man under ether anæsthesia; three or four days after the operation, he developed an acute dilatation of the stomach and for two or three days afterwards the patient was in such a wretched condition that he feared almost at any moment to see the patient die. He, however, recovered.

To his chagrin, due no doubt to the vomiting and frequent washing out of the stomach, he had noticed the moment the patient got up that he had bilateral recurrence of his hernia. He disappeared for six or seven years. He then came to him again, and he operated upon his bilateral recurrent hernia one week ago yesterday. He persuaded the man, because of his bad experience with acute dilatation of the stomach, to have his bilateral hernia operated upon with local anæsthesia. The first day passed off very well. The second, third and fourth and fifth days the man suffered again from symptoms of an acute dilatation of the stomach, in spite of the local anæsthesia. He is all right now.

He also called attention to a specimen presented by him a number of years ago at one of the meetings of this society, in which there was an acute dilatation of the stomach. The specimen was removed very carefully. It was seen that the dilatation of the stomach and duodenum stopped short just where the superior mesenteric artery crosses the duodenum. Of course, the real reason for the acute dilatation of the stomach is not known. There are several theories, but a large number of observers still cling to the mechanical theory, others cling to the nervous theory of acute dilatation of the stomach, and there are still other theories. Which one is right is not known, but the specimen showed proved in that case at least, that the mechanical theory of acute dilatation of the stomach was correct.

POST-OPERATIVE INTESTINAL OBSTRUCTION

Stated Meeting, held January 12, 1916

The President, DR. CHARLES N. DOWD, in the Chair

LATE POST-OPERATIVE INTESTINAL OBSTRUCTION

DR. SETH M. MILLIKEN presented a woman who had been operated upon for some pelvic condition in 1910. In April, 1914, she began to have pain in the abdomen and vomited. The vomiting continued without fever and no bowel movement after the onset. Enemata returned clear.

After three days she was admitted to Roosevelt Hospital with a pulse of 96 and a temperature of 94. When the abdomen was opened its lower portion looked as if it had been filled with cement. The small intestine was quite distended in the upper part of the abdomen, but the coils could be seen lower down perfectly flat. The intestine was traced down until a small band about the thickness of a piece of telegraph wire was seen on top of the mass of material which filled the pelvis. That was divided and the intestine lifted, showing a deep groove in it. It was found that the contents passed through, however, and the color returned. An attempt was then made to free some of the other intestines in the pelvis; the adhesions were stripped up for perhaps six or seven feet; no bleeding was encountered until the region of the uterus was approached. It never was seen and further interference was desisted from on account of the very dense adhesions. About a bottle full of melted vaseline was poured in and swashed around with the idea that it might keep adhesions from reforming. The wound was closed and the patient was in fairly good condition when she returned to bed. Her recovery was uneventful.

EXTREME EMACIATION FROM POST-OPERATIVE INTESTINAL OBSTRUCTION

DR. MILLIKEN also presented a woman, aged thirty-two years, whom he first saw on June 4, 1915, in the Medical Ward of Lincoln Hospital. The following history was given him:

Admitted on May 11, at which time she had been sick for six weeks, the first two weeks with a feeling of general malaise, the last four weeks with continual vomiting, and loss of flesh and strength. She complained of a good deal of abdominal and precordial pain, and vomited frequently, vomiting several times a day since in the hospital. Repeated attempts to take X-rays of her

stomach had been unsuccessful, because the barium was immediately vomited.

On May 25, rectal feedings had been instituted, while she was still allowed to take fluids by mouth; the vomiting persisted.

When seen by Dr. Milliken the woman was terribly emaciated, very feeble and irritable mentally, complaining of pain, and annoyed by examination. There was no sign of a mass in the stomach. There was a low median scar, the result of a complete hysterectomy for fibroma, with removal of both tubes and both ovaries and the appendix, done at the Lebanon Hospital, in July, 1914. After this she had improved for some time, but the vomiting, which became severe early in January, 1913, and was absent after operation, had come back early in February, 1915, and had persisted ever since.

Operation (June 7, 1915).—Incision through left rectus. One per cent. novocaine with 1/10,000 adrenalin local infiltration. Incision about three and a half inches long exposed a small, firm stomach, and all the intestines completely collapsed, the large intestine being about the size of an index finger, and the small collapsed to the size of a baby ribbon. The great omentum, which was a mere film, was adherent to the anterior abdominal wall scar below, but caused no band.

Stomach showed only a small white scar on the upper anterior surface of the pylorus. The duodenum was also collapsed. The pyloric opening felt smaller than a cigarette end. Pagenstecher guy sutures were inserted above, below and on each side of the scar, which was then excised transversely, and the wound united by tying the lateral sutures, using the upper and lower as tractors. The wound in the stomach wall was closed with two layers of Pagenstecher, enlarging the pylorus so that a thumb easily penetrated. The wound was closed in layers, and skin united with figure-of-eight silkworm-gut sutures. Time of operation was 45 minutes. Patient's condition no worse.

The stomach was washed out on the table, and four ounces of tap water left in. She returned to the ward with a pulse of 160, respiration of 24, temperature 99.4.

The pathologist's report on the specimen removed was that it presented no evidences of malignancy.

Fluid diet was forced immediately after the operation, and a good deal was retained, but for the first three days the patient vomited frequently. On June 11, third day post-operative, the patient retained all her nourishment, and the enema returned slightly discolored. She improved wonderfully for two weeks, the abdomen filling out, though the gain in weight was not marked. The bowels moved very slightly, without enema. The sutures



FIG. 1.—Emaciation from post-operative intestinal obstruction; condition immediately before operation for relief. Weight fifty pounds.

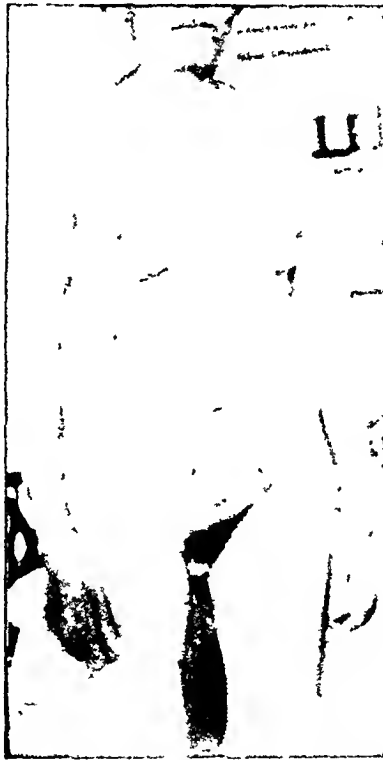


FIG. 2.—Condition one hundred days after final operation. Gain in weight fifty-nine pounds.

POST-OPERATIVE INTESTINAL OBSTRUCTION

were removed on June 21, the wound entirely healed by primary union. On June 24, sixteen days post-operative, the patient vomited a large amount of dark brown, frothy, undigested liquid, and continued to vomit on the 25th and thereafter until the 29th, when her condition had become grave, and the vomitus was distinctly fecal in character. She had apparently lost all the weight that she had regained, and was in desperate condition. She was so thin that the pylorus could be distinctly felt through the skin as a hard mass.

The abdomen was reopened by an incision along right rectus, from costal arch to about two inches below umbilicus. The incision was subsequently extended about two inches further. When the peritoneum was opened, the stomach was found distended with fluid. The pylorus was perfectly healed, no adhesions, scar soft. The thumb could easily be passed through the pylorus, and the stomach contents were easily compressed into the duodenum. As no obstruction apparently existed there, and as the obstruction had evidently been intestinal from the fecal vomiting, the small intestine was examined, beginning at the top, and rapidly traced all the way to the lower ileum, where a slight distention of the previously collapsed gut attracted attention. About five inches from the ileo-cæcal junction, a sharp, double-barrelled-shot-gun kink was found, adherent to the right wall of the pelvis. The kink was on the opposite side from the mesentery, and the adjacent surfaces of the gun-barrel were adherent for about one and one-half inches. This was separated with some difficulty, and the raw surface covered with a small piece from the omentum.

The patient was returned to the ward in fair condition, having stood the operation remarkably well. She was given nutrient enemas. She vomited once about two o'clock the next morning, and that afternoon the stomach was washed out, and only a small quantity of yellowish fluid obtained. At the suggestion of Dr. Anderson, my adjunct, two ounces of Russian oil was left in the stomach to encourage peristalsis, and fluid diet begun two hours later. The patient then made an uninterrupted convalescence, retaining all nourishment, and gaining marvellously each day.

On June 28, after the vomiting had commenced, and her condition had begun to deteriorate, she was weighed in her nightgown, and weighed exactly 50 pounds. At the time of operation on June 30, she had lost more than she had previously gained, and her astounding emaciation is well shown by careful study of the very poor photograph (Fig. 1). I believe at the time of the operation she did not weigh over 45 pounds. On July 21, three weeks after the operation, she weighed 60 pounds. On August 13 she weighed 70 pounds, and was gaining somewhat in strength. On the 19th

she weighed 77 pounds, and on September 1, 84 pounds. On September 24, eighty-six days after her second operation, she weighed 100 pounds, and could walk several steps with support. The general appearance was very satisfactory, and the static œdema in her legs, which had been very marked when she first got up, was beginning to diminish. On October 11 she was transferred to St. Andrew's Convalescent Hospital, where she gained very rapidly, and on November 13 she weighed 120 pounds, with her clothes, and was apparently in normal health, eating regularly, and rather forcing her diet. Her bowels are kept regular by 10 grs. of extract of cascara each night. Since then, by graduated exercises, her strength has improved, so that she can now squat very slightly, but if she attempts to go low she loses her power and falls. On December 20 she was walking quite freely, and weighed, with her clothes, 124½ pounds. Since January 8 she has gone out of doors, and is feeling perfectly well. She has cut out the extra feedings, and her weight at this time is 121½ pounds, in her ordinary clothes.

A history obtained late in July, when she seemed to be getting well, goes back to seventeen years of indigestion, with pain after eating, relieved by taking some powder on the point of a knife, and if obtained before operation, would have indicated gastric ulcer. However, her mental condition was also one of starvation, and it was probably impossible to get her to give such a history.

INCOMPLETE INTESTINAL OBSTRUCTION

DR. WILLY MEYER presented a woman, aged forty-one years, who had been operated on in July, 1915, for hernia, in one of the New York hospitals, and for appendectomy, cholecystectomy and gastro-enterostomy, on November 10, 1915. She made an immediate uninterrupted recovery from these procedures until the twelfth day after operation, when she suddenly complained of severe pain in left inguinal region; intestinal stiffening could be seen and felt, followed by loud gurgling sound. This repeated itself during the following days with attacks of vomiting. After the persistence of these symptoms for a week, without relief, a second laparotomy was done, which showed a band starting in the left lumbar region and passing across the intestines to the omentum. It distinctly compressed one coil, without, however having produced a pressure necrosis. This band was divided, and a number of other adhesions between omentum and intestines separated. Evidently an omental hernia had been present, and the handling of same had produced the condition described. On examining the small intestine, it was found that not far from the point of compression, firm

RESECTION OF STOMACH AND TRANSVERSE COLON

adhesions had transformed one coil into a clover-leaf-shaped stricture. Separation of the bands did not seem advisable; therefore entero-enterostomy. The patient made a perfect recovery.

The speaker does not remember a case where, after a simple herniotomy, an intestinal band had formed, producing incomplete obstruction.

SIMULTANEOUS RESECTION OF STOMACH AND TRANSVERSE COLON

DR. MEYER presented also a man, thirty years of age, who had been sick for over five years with stomach trouble. X-rays pointed to a mass, 4 inches from the pylorus, on the major curvature of the stomach, representing either a tumor, or a large, projecting ulcer. The patient was greatly reduced. Operation, November 19, revealed a large mass at the site mentioned which could still be excised. While proceeding with resection, it was seen that the posterior wall of the stomach was firmly adherent to the anterior leaf of the transverse colon. Separation was impossible. Therefore, simultaneous resection of transverse colon, which was done in the typical way; both ends of stomach as well as intestine closed. The splenic flexure was much adherent, evidently in consequence of the old ulceration in the neighborhood, and could not be moved forward to any extent. Mobilization would have been necessary in order to use needle and thread. Stump of stomach also was small. Therefore, as an emergency, Murphy's button was used for both places. A projecting mass on the posterior side of the abdominal wall proved to be a broken down, cheesy retroperitoneal gland, which was also removed.

The transverse incision which again had been used gave splendid access.

The patient made a quick recovery, the buttons passing 12 and 15 days after the operation. The specimen presented a large, transversely placed ulceration, surrounding the stomach from the side of the greater curvature for about two-thirds, with overhanging borders. Examination showed malignancy.

DR. WILLIAM DARRACH said that two months ago a patient came into the Presbyterian Hospital with a history that six hours previously she had been seized with a sudden severe cramp-like pain in her lower right abdomen. This pain continued in colicky attacks and remained in this one position. At that time, she had no other symptoms except

this acute, severe, colicky pain. She had no temperature, no increase in pulse; no leucocytosis and no rigidity. She gave a history of having her appendix removed eight years before. Since then there had been no further symptoms until this present attack. When the abdomen was opened there was found a band reaching from the sigmoid across to the site of the old appendix, of about the thickness of No. 6 Fr. sound. Underneath this was a coil of small intestine which was distended and moderately congested. It was removed, and a second coil was found to lie beneath the first. That also was removed, and then the band could be gotten at and was cut away from the sigmoid and also from its appendix attachment. The attachment at the old site was just at the angle between the terminal ileum and the cæcum, and was apparently due to the fact that in cutting the mesentery at the previous operation, the bare area had been left instead of being covered over.

This was the earliest acute obstruction he had seen. She was operated on eight hours after her original attack and, because of the early diagnosis, she made a very simple and uninterrupted recovery.

POST-OPERATIVE INTESTINAL OBSTRUCTION

DR. CHARLES L. GIBSON read a paper with the above title, for which see page 442.

DR. DARRACH remarked that intestinal obstruction is less frequently seen to-day than formerly, and he thought one reason for that was because the peritoneum is respected much more than it was ten years ago. When fluid is removed by a suction apparatus, such as Pool and Kenyon's, far less harm is done and the reaction to the injury of the operation is far less than when collections of fluid are mopped out of the peritoneum. Adhesions and consequent obstruction are much more likely to follow mopping than when fluid is either sucked out or allowed to remain behind. Frequently one sees perforated gastric ulcers where a tremendous amount of soiling takes place and yet no violent peritonitis and no bad adhesions result. Whereas, if that fluid is mopped out with violent sponging, the injury to the peritoneum and adhesions resulting in those areas will much more likely be followed by obstruction than if the fluid is left alone.

DR. HOWARD D. COLLINS said that a week ago he operated upon a patient for a small uterine fibroid and also for adhesions about the colon. Forty-eight hours later there was a very marked ileus. For the first time he had used pituitrin for ileus in this case. It worked extremely well. There was a response in about a minute and a half, but absolute paralysis after it. He repeated the dose in an hour and then another

POST-OPERATIVE INTESTINAL OBSTRUCTION

dose in two hours. Each time gave a marked discharge of gas, but the intestine remained paralyzed. On the following day he reopened through the peritoneum to take a look. The intestine looked perfectly normal and not markedly distended. The patient received doses of pituitrin ranging anywhere from every six to every four hours, from the third to the eighth day, when she died. He couldn't get anything through, except with the use of pituitrin, and then there would always be a response, but the promptitude was steadily decreasing until it took almost an hour before there was any response.

DR. N. W. GREEN related the details of a case at the City Hospital in the services of Dr. Collins and himself, upon which he operated about a year ago, following some pelvic operation at another hospital. At that time she gave symptoms of chronic intestinal obstruction, chiefly of the large intestine. Upon opening the abdomen there was found a mass of adhesions over the large intestine and in the region about the umbilicus. It was impossible to relieve all the adhesions, and as she was suffering from a dilated cæcum, showing that the obstruction was in the large intestine, he did what seemed to be the most feasible thing at that time, that was a cæcosigmoidostomy and not an ileosigmoidostomy. She went very well for a few weeks. Then after that she began to complain again of considerable pain in her abdomen. To-night Dr. Collins had informed him she ballooned up again, so that he was compelled to reopen the abdomen. Instead of closing off the pelvis, which he had neglected to do on account of the haste required at the time of the previous operation, a loop of small intestine had apparently slipped down behind this cæcosigmoidostomy and become caught there; which produced the later intestinal obstruction.

DR. H. B. DELATOUR said that his experience coincided with that of Dr. Gibson in that the majority of the cases of intestinal obstruction are post-operative. In making a diagnosis of intestinal obstruction, when it is complete, or nearly complete, one can receive considerable aid from the leucocyte count. In the cases in which obstruction has been complete the count has usually been above 20,000. In the immediate post-operative cases one usually finds a considerable length of intestine adherent, and in operating it is most imperative not to cease until one is perfectly satisfied that all points of adhesion have been separated, otherwise there will be a recurrence and persistence of the symptoms, and the operation will have been of no avail. It had been a matter of surprise to him to see the amount of separation one may do and the extent of raw surfaces which one has frequently to leave behind, and this without a recurrence of the obstruction. In such cases where two or three feet of intestine have been separated, there will be insufficient omentum or

other material to cover in all the raw surfaces. In these cases adhesions most likely take place, but fortunately are formed in such a way that no angulation is produced. The use of olive oil and other substances introduced in the abdominal cavity before closing the wound, to prevent adhesion, does not appear to be of much value.

In addition to the cases of complete obstruction such as Dr. Gibson has particularly referred to, there are many cases of post-operative adhesion and bands. Many of these patients are passed from one physician to another as neurasthenics, as they are constantly complaining of vague abdominal pains and, on a physical examination, nothing can be discovered. In a few cases the X-ray will show evidence of partial obstruction, but in most of them there are no pathological findings. He had operated many of these cases and found bands of adhesions which had at various points produced incomplete obstruction of some portion of the intestinal tract. In all patients who have had previous operation it is wise to bear in mind the probability of this form of adhesion and recommend re-operation.

DR. WOOLSEY called attention to a paper by himself in 1910 on a similar subject, taking fifty cases that occurred in the Presbyterian Hospital in the previous five years. It was noticeable then, and it is still more noticeable now, that the great majority are rather late cases. Formerly the majority of cases of post-operative obstruction were early cases that were due to sepsis. We are able now to handle these cases more successfully so that they do not result in obstruction. The pituitrin that Dr. Gibson has spoken of is one of the means that we have of prevention. In the cases he reported he used eserine salicylate, and he had had excellent results with it. Pituitrin is an excellent remedy, but he doubted that its results had been much if any better. When hormonol was being advertised, the advertisements spoke of the exceedingly spasmodic or spastic contraction which was produced by eserine instead of a normal physiological peristalsis. He had seen some remarkable results following the use of it. Pituitrin or eserine is especially useful in the cases that are just bordering on obstruction, which are due to atony from distention, as much as anything, and which if allowed to go on are going to result in obstruction of the bowels.

It is rather remarkable what cases are followed by obstruction. Some of the worst cases of adhesions are not followed by obstruction, and, *vice versa*, some of the milder cases are. He operated on a patient from whom the appendix was removed in the course of another aseptic operation. Healing was perfect. Five years later she was operated on for intestinal obstruction. A band had strangulated a loop of the small intestine.

POST-OPERATIVE INTESTINAL OBSTRUCTION

He had seen another case 15 years after an operation by Dr. Keen. A gangrenous loop of ileum was successfully resected. Obstruction seems not to affect most of the cases with very numerous adhesions and which we would think might result in intestinal obstruction. Perhaps it is due to the abnormal position of the intestines at the time adhesions take place, rather than to the number of adhesions.

DR. L. W. HOTCHKISS called attention to the paper presented by himself several years ago on this same subject, in which he confined attention entirely to the post-operative obstruction following operations for appendicitis. McBurney showed us several years ago, or at least he said, that secondary abscesses with obstruction were largely due to the character of the peritoneal infection. We all recognize, of course, the fibrinoplastic form of peritonitis which we see from time to time and in which we may have these obstructions from adhesions to wall of secondary abscesses and which the drainage is apparently ineffectual to prevent. He said he remembered that McBurney reported a case here, and he himself has had an experience of the same sort, wherein an intestinal loop which had been originally adherent on the right side pulled away and a secondary abscess formed on the left side with obstruction at that point.

As Dr. Gibson has found, he had lately also run against several obstructions due to bands and post-operative herniæ. Within the last few weeks he had had several experiences with these cases. In one case a large hernia had followed a comparatively simple abdominal operation. This was followed by strangulation in the hernia several years later, with gangrene of the gut and a fatal ending.

Last fall he had a case in which intestinal obstruction followed twenty years after the original operation. The doctor thought it was a typical biliary colic. He said he would make the same diagnosis again in a similar case. The woman had such terrific pain. He found at operation 4 days later ten feet of small intestine caught in a band which apparently had resulted from an operation twenty years before. The intestine was entirely gangrenous and the patient succumbed on the fourth day after the operation.

A case of that sort disturbs one a good deal. It is not clear what we are going to do about it. Dr. Gibson has not presented any corrective. These cases undoubtedly occur, and it is up to the men who see the cases and make the diagnosis (and a great many of these cases, as Dr. Gibson has remarked, are not comprehended at all). Those of us surgeons who watch these cases which are partially obstructed understand that when complete obstruction sets in immediately there is

a very definite change in the patient's pulse and expression and we waste no further time. After all, it is a question of early diagnosis.

DR. MILLIKEN had seen a case where a man had been stabbed, wounding the concavity of the splenic flexure, with a good deal of hemorrhage. The exploratory was made through the left rectus incision and then the transverse incision was carried around from about the middle of the incision to the tip of the twelfth rib. In that case he did not catch the rectus muscle above and below, as Dr. Meyer recommends, and he regretted it afterward, because apparently a small hæmatoma occurred there with an extensive infection. The upper half of his rectus and the upper half of the oblique muscle sloughed out. No hernia resulted. He has a tissue paper wall which seems to flap in and out, but there is no herniation. It is a perfectly good abdominal wall without any muscle in upper left quadrant.

DR. WM. C. LUSK endorsed the use of pituitrin in cases of post-operative ileus. In two such cases the use of pituitrin was followed by what seemed to him very remarkable results. In the first case in which he ever used it, he had tried numerous enemata without success and had about given up in despair when the house surgeon said to him, "Why don't you give a dose of pituitrin?" He said, "You can give the patient anything that offers any chance of causing the bowels to move." He injected the pituitrin and within half an hour the bowels had moved copiously. He went home feeling that in pituitrin there had been added to surgery a great adjuvant in the treatment of this complication. The difficulties and the result in the second case were similar to those in the first. He had seen pituitrin move the bowels in septic peritonitis.

DR. DOWD said that it is manifest that all unnecessary traumatism should be avoided. But men differ in their conception of what constitutes unnecessary traumatism. Small drains will often be as efficient as large ones. Simple drainage of abscesses is often more efficient than extended efforts to clear their walls. The intestines may usually be left undisturbed if the primary focus of infection is removed. We are continually learning that manipulations are unnecessary which were formerly considered essential. In our teaching and in our practice it is surely wise to emphasize these facts if we would avoid these troublesome adhesions.

DR. ALEXIS V. MOSCICOWITZ said that almost everybody must have seen cases of bands and adhesions formed after the simplest operation, and that is not at all surprising. However, almost everybody must also have seen cases where one might expect very voluminous adhesions, and when these cases come to a secondary operation they have entirely

CARCINOMA OF THE RECTUM

disappeared. He believed the crux of the entire matter is the question of productive inflammation. Unfortunately, no one knows what causes productive inflammation, and more unfortunately still, no one knows how to prevent a productive inflammation.

CARCINOMA OF THE RECTUM

DR. WILLIAM DARRACH presented the following case:

A woman, fifty-six years of age, who came to the Presbyterian Hospital, April 26, 1915. Physical examination revealed a cauliflower-like mass to be felt and seen about three inches within the anal margin. The rectum was freely movable and the posterior vaginal wall did not seem to be involved.

On April 28, 1915, with the patient in the Trendelenburg position, a 5-inch, left rectus incision was made and deepened through the peritoneum. The mass could be felt just above the levator ani muscles. No glands could be felt either near the growth or higher along the course of the vessels. The liver seemed normal. The sigmoid was long and with a free mesentery. The peritoneum of the latter was cut and stripped back and the vessels tied off and cut. The bowel was crushed, cut with the cautery and both ends invaginated. The peritoneum was then cut on either side of the mesentery of the distal portion of the gut, near its posterior attachment, and stripped back on either side almost to the brim of the pelvis. The underlying fat and contained structures were stripped away from the pelvic walls down to the pelvic floor and the bowel separated from the uterus and vaginal wall. The mass was then dropped into the pelvis, a towel placed over the wound, and the patient put in the lithotomy position. The anus was surrounded with a circular incision and the anal opening closed with silk. The incision was carried back to the coccyx and deepened to the levator ani muscles. The latter were cut through about an inch from their rectal attachment and the whole mass pulled out from below. Bleeding points were carefully ligated and two large strips of gauze inserted up to the hollow of the sacrum. The wound was closed in front and behind these strips and the patient again put in the Trendelenburg position. The peritoneal flaps were closed with continuous catgut and the proximal end of the bowel pulled out through an intermuscular incision a little to the inner side of the anterior superior spine. The skin opening was a little above and outside the muscular opening. The edges of the bowel were sewn to the skin edges. The rectus incision was then closed tight in layers.

The operation lasted two hours. After the operation she received 600 c.c. of salt solution intravenously and also had about

a quart of hot saline poured into her peritoneal cavity just before it was closed. There was no nausea or vomiting afterward and she was put up in a Gatch bed after a few hours. Her temperature was between 98° – 100° most of the time during her convalescence, reaching 101° once, on the sixth day. Her highest pulse rate was 84. The perineal gauze was removed on the second day after operation and there was a purulent discharge from that wound for several weeks. At the end of the second week the posterior vaginal wall sloughed over a small area and this left a sinus communicating with the perineal wound which has persisted intermittently ever since. The colostomy was opened on the third day and has functionated very well since. She has one movement a day following a small enema with no leakage between times. Gas escapes very rarely. Part of the day she wears a cup over it attached to a narrow webbing band. Six weeks ago the skin around this opening had contracted down so that it would not admit a finger. Under novocaine it was enlarged at both ends. At present there is no sign of any recurrence and she is enjoying the best of health.

FRACTURE OF THE UPPER EXTREMITY OF THE HUMERUS TREATED BY THE ABDUCTION METHOD

DR. ROYAL WHITMAN presented a girl nine years of age to illustrate a perfect functional result after fracture of the upper extremity of the humerus just below the epiphysial junction, treated by the abduction method. The patient had been admitted to the Hospital for the Ruptured and Crippled last August, within a few days of the injury, because attempts at reposition of the fragments had been unsuccessful (Fig. 3).

In cases of this class, of which this was a typical example, the shaft of the humerus is usually displaced upward in front of the head. Reduction by ordinary means is not often successful, and in many instances the head of the bone is subsequently removed in order to restore motion. The injury was therefore of more importance in childhood than in adult life, because of its effect upon the development of the arm.

The method of reduction was as follows: The arm was raised almost directly upward, thus moving the extremity of the shaft downward, and at the same time rotating the scapula, making the joint prominent laterally. By traction on the arm, and by leverage on the acromion the fragments were disengaged, and the head replaced by direct manipulation (Fig. 4).

A shoulder spica was then applied with the arm in the elevated position, with such rotation and forward inclination as most perfectly adjusted the fragments.



FIG. 3—Radiograph taken through the dressing on admission, showing the characteristic displacement of the shaft forward and upward, the head lying behind and below



FIG. 4—Radiograph taken through the plaster splint after reduction. The arm is at an angle of about 130 degrees (40 degrees below the limit of abduction) and the forearm being about the same with the fore arm flexed over the head. The crease in the skin of the humerus caused by the attitude and by the rotation of the scapula is visible.

ARTHROPLASTY FOR ANKYLOSIS AT ELBOW-JOINT

In this instance the forearm was flexed over the forehead as if to protect it. He had called the procedure the abduction method because it was somewhat similar to that for fracture of the neck of the femur. He thought this the only practicable method of reducing displacements of this character, and of fixing the fragments subsequently, since this was assured by pressure and by the force of gravity, as well as by the splint.

He had first employed the treatment in 1902 (*ANNALS OF SURGERY*, May, 1908), and always with success since that time, and although all the patients were children it should be equally efficacious in the treatment of adults if applied soon after the injury.

DR. CHAS. N. DOWD said that he had treated two such cases in adults this fall. In both instances the fragments had gone under the coracoid. Under ether, even with the aid of incisions, it was impossible to get the fragments back. One of them had been displaced for a long time, and the fragment was very firmly imbedded. In the other case the operation was done three days after the injury, and it was impossible to get the fragment back, even when two incisions were made, so he was sure that there are a great many more difficulties in muscular adults than there are in youngsters. In both of these cases the fragments were removed.

ARTHROPLASTY FOR ANKYLOSIS AT THE ELBOW-JOINT

DR. WHITMAN presented a girl nineteen years of age, on whom he had performed arthroplasty for ankylosis at the elbow.

He said that the history of the case began with the treatment of the tuberculous disease in early childhood, which had resulted in practical ankylosis. Four years before, he had attempted to restore motion by arthroplasty, interposing flaps from the neighborhood of the joint, but after a comparatively short period motion was again lost.

In August, 1914, a second operation was performed, at which it was found that the original fibrous ankylosis had been transformed by the previous operation to solid bone. A new joint was fashioned in the usual manner, permitting under traction a separation of half an inch. The surfaces were then covered by a flap of fascia from the thigh. The result was very satisfactory in restoring function. There was perfect flexion, extension to 165° , and a sufficient range of pronation and supination without laxity of the articulation.

In cases of ankylosis following tuberculous disease in which the tissues about the joint were atrophied he thought that the free fascia transplantation was essential to success.

BOOK REVIEWS

BONE-GRAFT SURGERY. By FRED H. ALBEE, M.D. W. B. Saunders Co., 1915.

Ollier, Nélaton, Malgaigne, Velpeau, Esmarch, Dieffenbach, Volkmann, Mikulicz, Adams, Liston and Ogston—the pioneers of modern bone-surgery—perhaps little realized that they were laying the foundations for a surgery of bone that should transcend their fondest hopes. The antiseptic era, into which they lived, developed as its greatest achievement the possibility of implanting dead and inorganic material to take the place of missing bone. This was regarded as the wonder of the antiseptic art. Now comes the newer bone-surgery. Foreign substances, it is shown, are antagonistic to nature. Autogenous material harmonizes. Living bone may be transplanted into living bone, and a healthy growth continued with but little interruption of the normal processes. By introducing living autogenous bone into a bone-defect in such a manner that corresponding structures are made continuous—periosteum to periosteum, endosteum to endosteum, and marrow to marrow—results are secured which actually restore the normal physiologic conditions; with which prosthetic implantations, braces, fixation apparatus, and amputations are in no sense comparable.

The newer bone-surgery is revising the whole subject of amputations. The loss of a large part of the proximal bone, supporting a limb, is no longer a cause for sacrificing the whole member. The shaft of the femur, humerus, and phalanges may be restored by implantation of living bone, and amputations obviated. Indeed, this new bone-surgery, in conjunction with blood-vessel anastomosis and reconstruction, nerve suture and neuroplasty, tenoplasty, and skin and connective-tissue flap-construction, promises to make amputations of limbs a rare procedure in the realm of modern surgery.

Cellular life, it is now known, is independent of the life of the whole organism. The individual cells of the body do not die when the phenomena which are called death intervene. Bone tissue, as well as all of the other tissues, is still alive in the true biologic sense long after the somatic activities of respiration and circulation have ceased. Morfurgo has shown that the periosteum of a corpse can produce new bone one hundred and sixty-eight hours after the death of the individual. It is not true that transplanted bone acts only as a scaffolding for the growth of new bone from without. Grafts of living bone have life inherent in

BOOK REVIEWS

them, and are capable of retaining their bony qualities and of developing more bone.

Dr. Albee has presented the fundamental principles of bone histology, growth, repair and degeneration. These newer conceptions are quite essential to the surgeon for a happy prosecution of his work. The technic of bone-grafting is made clear. The many ingenious devices which are employed for cutting grafts in the desired shapes, for making dowels, and for excavations for the reception of transplants are all presented.

Bone-grafting is well described in the treatment of tuberculous spondylitis. The author calls this Pott's disease, although in fact, so far as ownership is concerned, the disease belongs to the patient and not to Mr. Pott, and so far as the disease is concerned, Mr. Pott's grandfather possibly had it, and his father's family physician might have written a better description of it than he did. This same Percival Pott published a pamphlet on the anatomy of congenital hernia after he had visited the Hunters and had been shown their beautiful dissections of hernia; but the name of Hunter does not appear in his pamphlet. Now we find him riding down the avenue of time on the backs of the unfortunate victims of a very old and common disease. It is high time he is dismounted. The patient and the surgeon have enough to contend with without having Pott imposed upon them as a perpetual mortgage.

Dr. Albee presents the new treatment of spondylitis. Fixation is secured by the bone graft, applied to the spinous processes. It is indicated at all ages where pain or muscular spasm proclaim sinking in of the vertebral bodies. The earlier the operation is done, the better is the prognosis. It is especially indicated in the presence of increasing deformity, and complications such as psoas spasm, abscess, and paraplegia. The results are better than by any other method of treatment.

Bone-grafting is described for paralytic scoliosis, spina bifida, and sacro-iliac disease. In the treatment of fractures, metal plates, as recommended by Mr. Lane, are unqualifiedly condemned. It is conclusively shown that such foreign bodies cause osteoporosis and defeat the conditions they are supposed to help. Metal, in the form of plates or wire, is not to be advised for bone-fixation. Metal causes absorption of bone; bone-grafts cause a deposit of bone. The device for treating fractures of the surgical neck of the humerus is beautiful. The same is true of fracture of the olecranon. The wedge-shaped grafts, used to enlarge the bone-ends in old ununited fractures, are most effective.

The technic of treating fractures of the neck of the femur, patella, os calcis, lower jaw, and other bones is well presented. Osteoplastic

operations on the hip and knee are quite original. The range of application of bone-grafting in diseases of the joints is very great. Bone-grafting in the treatment of club-foot introduces the new principles which produce the most perfect operation yet devised. New bone is placed where bone is needed to remedy a defect which is characterized by absence of bone.

This book of Dr. Albee's is one of the most useful surgical publications that has appeared in these particularly unfruitful times.

JAMES P. WARBASSE.

AUTOPLASTIC BONE SURGERY. By CHARLES DAVISON, M.D., and FRANKLIN D. SMITH, M.D. Philadelphia: Lea & Febiger, 1916.

This book deals with the same subject as that of Dr. Albee, although the two titles are quite different. The first book is something less than bone-graft surgery, the second is something more than autoplasmic bone surgery. Each deals with autoplasmic bone-graft surgery, as their titles should so imply.

This work of Davison and Smith, one of whom is a surgeon and the other a pathologist, presents an illuminating résumé of bone physiology and pathology. Even the history of these subjects is not slighted. The earliest report of bone transplantation is found to date back to 1682. It is discovered in the work of A. Blasio, published in Amsterdam. Here is found a decree against Jobus Meekren: "*Chirurgicum ossis cranii fragmentum auferre jussit, sique, curatione alia adhibita excommunicationis vim effugit.*" Jobus Meekren had transplanted a piece of the skull of a dog into a defect in the skull of a soldier. At this time and place the Christian Church was so powerful that Jobus Meekren was forced to remove the implanted bone or suffer excommunication from the church, which no man who had his livelihood to earn could afford to suffer. This monumental piece of surgery was referred to as "an unchristian" method of treatment.

One of the striking facts which experience has brought out is that the wound of transplantation is no more likely to become infected than any other wound of bone. The transplant consists of living tissue, which has positive germ-resisting properties. When the transplant becomes infected it becomes exfoliated only in a small proportion of cases. The authors think very highly of the inlay-transplant method of Albee, used in fractures, which consists in sliding across the fracture a graft taken from the long fragment.

The influence of the X-ray upon diagnosis is seen in the reports of cases in which the surgeon dares not state that his examination shows a fracture. The following is the modern method of expression: "Exam-

BOOK REVIEWS

ination *showed* a man with the *symptoms* of fracture of the upper end of the left humerus. A röntgenogram *revealed a fracture* through the anatomical neck of the humerus." Before the days of the X-ray it was the surgeon's examination that *revealed* the fracture; nor did the surgeon in those days hide behind the hypothetical implication of symptoms.

This book contains many pictures, showing upon prepared specimens of bone, the methods of making transplants. There are many pictures of fractures which show nothing more than the fracture. They imply that bone-grafting would remedy the defect, but in many of them other treatments would be equally effective. For fracture of the neck of the femur a peg made of the fibula is used, although it would seem that a tibial graft would answer as well; and there is no doubt but that the loss of the fibula weakens the leg of a working man. This book, like that of Albee, shows abundant proof of the deficiencies and harm of metal plates in the treatment of fractures.

The crest of the tibia is called the spine of the tibia, which is surely a very poor name for a crest. In the treatment of old, ununited fractures of the patella, all methods are given but the best, which is that described by Albee, making use of an hour-glass shaped transplant.

In this book is described the very effective method of Hibbs for securing bony union between the spinous processes for spondylitis. Albee does not mention it. The method of Halsted and that of Don for securing spinal ankylosis are described, although ignored by Albee. The operation for congenital dislocation of the hip seems like a better procedure than that described in Albee's book. The plastic operation shown for covering defects of the skull by means of a transplant from the scapula is beautiful. Both books show the very effective transplant method described by W. W. Carter, for the cure of nasal defects.

This book supplements that of Dr. Albee, and the book of Dr. Albee supplements this. The field of autoplasmic bone-graft surgery is so large and is developing so rapidly that many books may yet be written before a redundant publication appears.

JAMES P. WARBASSE.

A MANUAL OF SURGERY FOR STUDENTS AND PHYSICIANS. By FRANCIS T. STEWART, M.D., Professor of Clinical Surgery, Jefferson Medical College. Fourth Edition, 774 pages, 580 illustrations. Philadelphia, Pa.: P. Blakiston's Son & Co., 1915.

That a fourth edition of this book has appeared means two things. There is a demand for the book, and the author is attempting to keep the statements contained in the book up to date, in such a treatise a most difficult task.

BOOK REVIEWS

The book is a Manual which does not pretend to be exhaustive excepting in the number of subjects considered. It is a concise statement about many surgical diseases systematically arranged. It is carefully edited. Comment upon the subject matter is impossible in any brief review. The volume is a compendium or index of surgery. It will serve as a convenient and safe guide to the undergraduate student of surgery.

CHARLES SCUDDER.

STUDIES IN SURGICAL PATHOLOGICAL PHYSIOLOGY FROM THE LABORATORY OF RESEARCH OF NEW YORK UNIVERSITY. Volume I, 1915.

This little volume contains a series of papers which record work done in the laboratory of experimental surgery of the New York University. It represents, therefore, work which is peculiarly characteristic of the newer surgery of the present decade. As stated by Dr. John William Draper, by whom the papers have been edited, and who in the faculty of the University is the associate in charge of the Department of Experimental Surgery, these papers are the result of surgical investigations which have had to do, first with problems of functional diagnosis, and then have proceeded to the consideration of therapeutic progress as depended upon these, and lastly upon details of method and technic. The point of view from which the work of a laboratory of surgical research is to be considered is best presented in the paper by Drs. Stewart and Draper which was read before the American Hospital Association at San Francisco in June last. This paper is a plea for the further development and enlargement of experimental work in surgery and a demonstration of the importance of a surgical laboratory in hospital work. It is summed up in its concluding paragraph as follows: "Full recognition of graduate schools and a free hand to correlate surgical studies upon lower mammals with coördinate studies upon the highest mammal, man, in the surgical laboratories and in the hospital wards, will tend further to fuse medicine and surgery, improve the grade of students, diffuse knowledge, and ultimately serve to lighten the burden of fostering medical progress." The work which Dr. Draper and his associates have been endeavoring to do in their laboratories, the results of which are presented in this collection of papers, has the full sympathy and admiration of the ANNALS. It is a satisfaction to the writer to note how much of this work has already been brought to the attention of the medical profession through the pages of the ANNALS OF SURGERY. This book ought to be a stimulus to thoughtful surgeons everywhere for the future development of work along similar lines.

LEWIS S. PILCHER.

CORRESPONDENCE

THE ROLE OF ABDUCTION IN THE TREATMENT OF HIP FRACTURES AS COMPARED WITH ARTIFICIAL IMPACTION

TO THE EDITOR OF THE ANNALS OF SURGERY:

Dr. F. J. Cotton introduces his interesting paper, published in the March issue of the ANNALS OF SURGERY, with the very kindly and complimentary statement "that between Astley Cooper and Royal Whitman I know of nothing worth while save a paper by Newton Shaffer on work done about 1886." Further, "Whitman has done something real, contributing to real results along the lines Shaffer first laid down."

Shaffer's paper, to which he refers, describes the successful treatment of a case of ununited fracture of the neck of the femur by means of a Taylor traction hip brace supplemented by a surcingle for pressure on the trochanter.

The brace was applied with the limb at an angle of 45 degrees of flexion and 20 degrees of abduction, the object of the abduction being to oppose the constant pull of the traction brace to the contracted adductor muscles, and thus with the aid of direct pressure to assure the contact of the fragments.

It should be evident, however, that muscular resistance and shortening established by three months of non-union, as in Shaffer's case, are not present in recent injuries, and that the traction hip brace is simply a modification of traction treatment. If the hip brace were at hand, and if it could be applied and supervised by a Shaffer, it might be of practical value in recent cases, but hardly so under the ordinary conditions of practice.

"The lines laid down by Shaffer," *i.e.*, 20 degrees of abduction to utilize a supposititious adductor tension, and a plaster spica in place of the traction brace, which alone could make those lines effective, represented Cotton's conception of the abduction treatment when his book was published; a confusion that apparently still persists.

The genesis of the abduction method had no relation whatever to the Shaffer treatment. It was originally devised for the correction of the deformity of incomplete fracture in children, by utilizing the leverage of the limb, the tension of the capsule, and the fulcrum of the acetabular rim to restore the normal angle of the neck.

As applied to complete fracture, the displacement is first reduced by manual traction under anæsthesia. The limb is then drawn outward and fixed in complete abduction and complete extension by a plaster spica. The mechanism is dependent on the tension thus produced upon the capsule, which directs the fragments toward one another, forces a contact, and locks the parts by mutual pressure. In some instances, also, there is actual engagement of the outer fragment beneath the acetabular rim, or contact of the trochanter and the pelvis that still further assures security. Muscular tension, except in the sense that it is completely relaxed, has no part in the adjustment.

The abduction method in a comprehensive sense is the only effective means of applying surgical principles: namely, the immediate reduction of the deformity, whether complete, incomplete, or impacted, whether at the base or at the extremity of the neck, and securing fixation of the fragments for a time sufficient to permit union. These essentials are supplemented by adequate protection during the period of repair.

Dr. Cotton states "that fractures at the base of the neck (extra-capsular) are going to unite anyhow, with good or bad treatment."

"Intracapsular fractures, if unimpacted, never unite by bone under routine treatment. Well impacted fractures do so unite." Consequently one should induce artificial impaction.

Dr. Cotton has made the statement elsewhere "that the majority of hip fractures are impacted." It follows, therefore, that bony union results in the majority of cases irrespective of the character of the treatment.

Assuming, for the sake of argument, that he is correct, then the disability that characterizes the majority of cases—a characteristic thoroughly established by every investigation of final results—is not due to non-union, but to unreduced deformity; consequently, the reduction of deformity is the essential preliminary to success.

In order to prepare for artificial impaction, displacement is reduced under anæsthesia, and after the "malleting," the limb is fixed in abduction by a plaster spica, and, judging from the illustration of the most successful case (Fig. 11), in full abduction. Now since abduction and artificial impaction are so combined, which of the two is of greater importance?

It can be easily demonstrated that deformity may be reduced, and that the fragments may be held in forced contact with one another by the proper application of the abduction method. What, therefore, is gained by malleting the trochanter "until something gives," which can only mean further injury to an already injured bone? Artificial im-

CORRESPONDENCE

paction must be supplemented by the support of a plaster spica in abduction, and it may not even assure, by itself, permanent security, since according to Cotton "always in hip fracture there is considerable absorption" which should be most evident at the seat of greatest injury, the artificial impaction.

I conclude, therefore, that the great advantage of artificial impaction is the manipulation that precedes it and the fixation that follows it. If, therefore, impaction is the necessary incentive to reduction of deformity and adequate protection I should be willing to accept it on that account. Cotton, however, in his enthusiasm for artificial or incidental impaction, loses sight of the dependence of normal function upon normal form. In a previous paper he has stated that "it is a crime to disturb an impaction in fairly good position," and in this article he speaks of "deformity in adduction and eversion not great enough to warrant any interference." But since a certain range of abduction is essential to a normal gait, there can be no degree of adduction so slight as not to warrant correction, because it may be safely and easily accomplished, in the manner that I have so often described.

The abduction method, as an efficient and exact means of accomplishing a definite purpose, requires a certain technical facility in its application, and above all an understanding of the mechanical principles on which it is based. It is placed at an unnecessary disadvantage by the misconceptions of the writers of text-books and special treatises, who, lacking both understanding and practical experience, present interpretations in the place of reproductions of the author's descriptions, one of which may be found in the ANNALS OF SURGERY for October, 1914.

ROYAL WHITMAN.

New York, March 8, 1916.

REPAIR OF VESICOVAGINAL FISTULA.

ANNALS OF SURGERY:

Since the publication of Dr. Charles H. Mayo's paper, "Repair of Vesicovaginal Fistula," in the January issue of the ANNALS, in which he says: "I am personally indebted to the late Dr. Bernays for the principle of the operation, though I am unable to say whether it originated with him," he has learned that the operation was devised by Dr. R. F. Amyx, and first performed by him December 17, 1902. It was demonstrated to Dr. Bernays the following year."

MAUD H. MELLISH,
Mayo Clinic, Rochester, Minn.

February 12, 1916.

To Contributors and Subscribers:

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N. Y.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS of SURGERY

227-231 S. 6th Street

Philadelphia, Penna.

ANNALS *of* SURGERY

VOL. LXIII

MAY, 1916

No. 5

SUGGESTED OPERATIVE STEPS DEALING WITH SPONTANEOUS INTRACEREBRAL HEMORRHAGE (APOPLEXY)*

BY CHARLES M. REMSEN, M.D.
OF ATLANTA, GA.

IN all cases of spontaneous intracerebral hemorrhage there are three indications: (1) To relieve the general increased cerebral pressure subsequent to the escape of unconfined blood under high pressure into the cerebral tissue, this pressure then being transmitted to the neighboring tissue resulting in marked physiological disturbances; (2) to relieve localized direct pressure upon the internal capsule, disturbances or destruction of which lead to severe projection symptoms; and (3) to prevent extension of the cerebral excavation by hemorrhage.

The first of these indications involves procedures intended to tide over a temporary period during which the intracranial pressure may be so great as to interfere with the proper functioning of the cardiac and respiratory centres, which interference, if allowed to continue, in the natural course of events may, as is so often seen, terminate fatally.

For the second of these indications, steps are planned to relieve the local pressure upon the delicate fibres of the internal capsule, and thus prevent the transformation of a physiological block into destructive laceration or pressure atrophy, either directly due to the reactive œdema about the hemorrhage or to the pressure of the hemorrhage itself.

The third indication calls for methods by which the hemorrhage is prevented from burrowing down the brain stem, out to the cortex, or into the ventricles, processes which may lead to serious disturbances, nuclear involvement, hemianopsia, or disturbed function in almost any portion of the brain, and, if allowed to pursue its course without intervention, may be the direct cause of death.

Thus it will be seen that these procedures not only serve to prevent an immediate fatal ending, but also to prevent or alleviate the paralyses

* Reported at the October, 1915, meeting of The Atlanta Neurological Society.

considered almost an essential sequela of the apoplectic stroke, and which may be complete as a result of too long continued physiological disturbance.

A study of the pathology of spontaneous intracerebral hemorrhage indicates that these results may be best accomplished in a large percentage of cases by confining our field of activity to a certain fairly well-defined area, and the method of intervention as suggested here and employed by us¹ is given below in a series of sketches which from their text may be easily understood.

It is seen that these principles not only involve decompression, as has been suggested before, with the idea of relieving an otherwise possibly fatal intracranial pressure, but also involve the evacuation and drainage of the hemorrhagic cavity, with a view (1) toward eliminating the

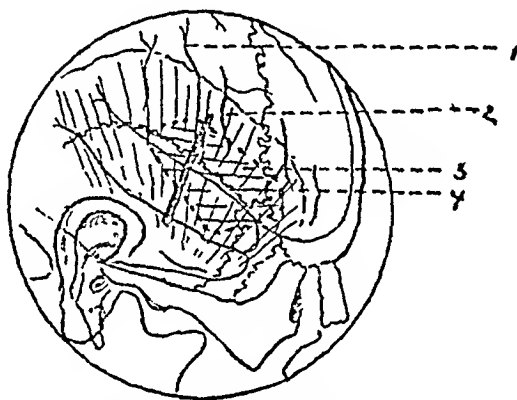


FIG. 1.—Semi-transparent sketch showing the relative anatomy of the island, Rolandic fissure, temporal muscle to the cranium. Heavy lines show line of incision. 1, fissure of Rolando; 2, line of incision; 3, surface projection of the island; 4, upper boundary of the temporal fossa.

continued excavation of the hemorrhage from the striate body elsewhere into more important structures; (2) toward relieving the direct pressure upon the capsule itself by this hemorrhage, and thus interfering with the appearance of permanent paralysis, the hemiplegia of apoplexy; (3) towards escaping the indirect results of the perihemorrhagic reaction, oedema, anæmia, pressure which, if continued, may cause destruction and paralysis as well as the pressure of the clot itself, and (4) towards obviating the formation of the so-called apoplectic cyst, so often formed by the intracerebral retention of spontaneous or traumatic hemorrhage.

No attempt is made to enter into a discussion here of the particular physiological, anatomical, and pathological bases for this general

¹ Remsen: Surgical Measures in Apoplexy. Report of a Case. J. A. M. A., July 10, 1915.

OPERATIVE RELIEF OF APOPLEXY

method of intervention² in this article, but merely the successive steps of the operation are indicated with the hope that this may serve its purpose in a not too small percentage of cases of intracerebral hemorrhage heretofore treated only symptomatically.

Pre-operative Treatment.—Such patients are debilitated and prone

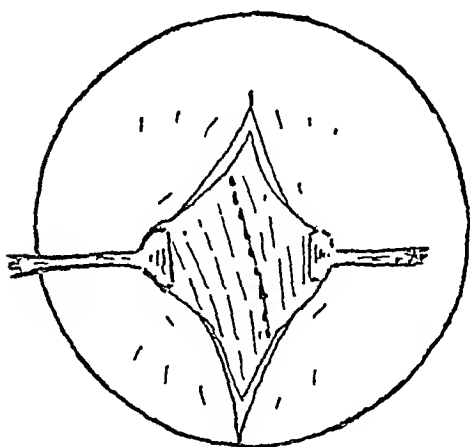


FIG. 2.—Showing skin edges drawn apart, together with the edges of the temporal fascia. The fibres of the underlying temporal muscle are seen and the dotted line represents the line of separation of these muscle fibres.

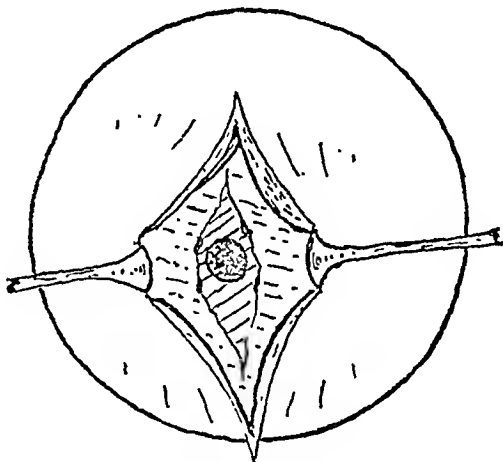


FIG. 3.—Showing the skin, temporal fascia, and temporal muscle drawn aside. The underlying periosteum has been incised and pushed aside, revealing the underlying bone. Through this a trephine opening has been made preparatory to the enlargement of this opening by the rongeurs.

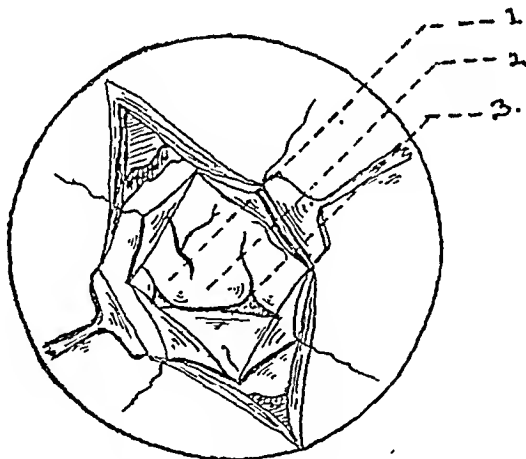


FIG. 4.—Here the skin, temporal fascia and muscle have been retracted, a larger opening made in the skull, and a crucial incision made in the dura. These dural flaps are shown being reflected. 1, par opercularis; 2, Broca's convolution; 3, gyrus temporalis superior.

to pneumonia. The administration of 1/150 of atropin is exceedingly important in order to obviate as far as possible the possibility of aspiration pneumonia. It is not at all unlikely that patients will need no anaesthesia of any sort, owing to either a semiconscious or comatose

²Remsen: Apoplexy. Surgery, Gynaecology and Obstetrics, December, 1915.

state. Urotropin is administered in generous doses before operating, since there will be drainage for several days of blood and cerebrospinal fluid.

Step No. 1.—The head is shaved over the entire half of the side which is to be subjected to operative procedures. The usual aseptic precautions are followed.

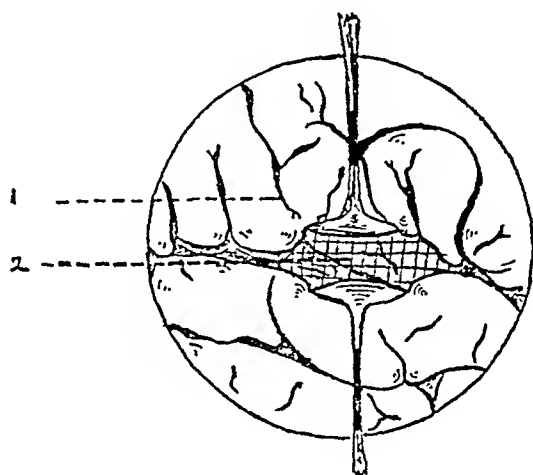


FIG. 5.—The actual seat of operation is shown in about natural size. Here the opercular borders are drawn apart, revealing the gyrus longus and the gyri breves of the surface of the insula. 1, lower end of Rolandic fissure; 2, surface of the island seen deep in the cleft (screened area).

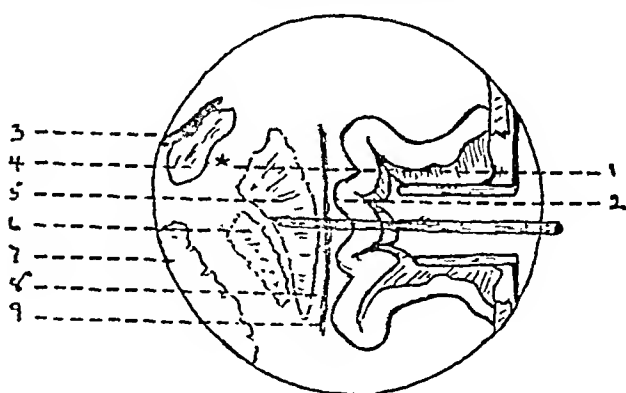


FIG. 6.—This shows a sketch of the cross-section of the field of operation. The opercular borders are shown drawn apart and the trochar enters successively the gray and white matter of the island, the claustrum, the external capsule, and the putamen. When hemorrhage is found in the region of the striate body a drain is inserted along the tract indicated by the trochar in the illustration. The opercular borders are allowed to fall together, and the drain is led out through the skin. 1, internal capsule; 2, gray matter of the island; 3, ventricle; 4, head of caudate nucleus; 5, putamen; 6, globus pallidus; 7, nucleus lateralis thalami; 8, the external capsule; 9, the claustrum.

Step No. 2.—A vertical linear incision is made anterior to and well above the external auditory meatus (see Fig. 1).

Step No. 3.—Bleeding points are carefully controlled, and the skin-flaps drawn back firmly. This exposes the temporal fascia. A similar

OPERATIVE RELIEF OF APOPLEXY

incision is made through the temporal fascia and these two leaves drawn back. This exposes the fibres of the temporal muscle (see Fig. 2).

Step No. 4.—The fibres of the temporal muscle are separated, not cut. Their direction may be slightly oblique to the overlying linear incision. On retracting these two edges the parietal and squamous portions of the temporal bone are exposed. Either with a burr or trephine an opening is made in the underlying bone. By retracting

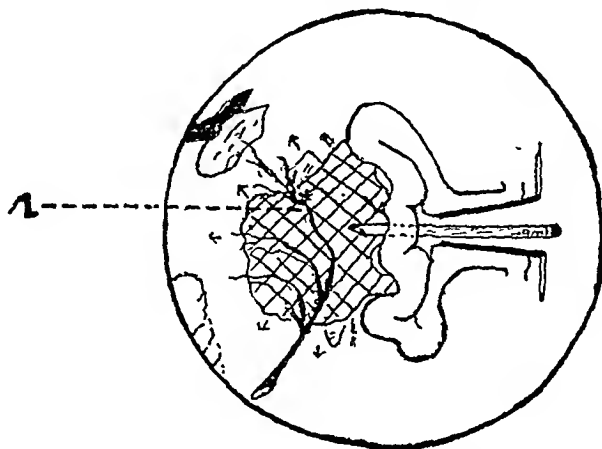


FIG. 7.—Cross-section—compare with Fig. 6. Here, screened area shows schematic representation of a hemorrhage. The trochar is seen entering this area by way of the surface of the island. 1, the arterial branch which is involved in the great majority of cases of apoplexy. The arrows show the lines of force exerted upon the internal capsule and surrounding tissue.

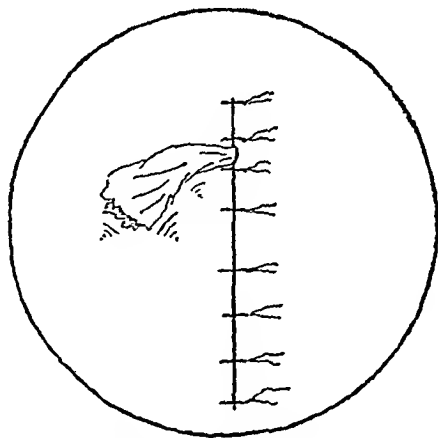


FIG. 8.—Shows the operation as completed, with the drain led out through the upper portion of the incision.

and lifting up the temporal muscle edges it is possible to enlarge this opening rapidly with the rongeur forceps. An opening is made somewhat larger than the silver dollar. The underlying dura is now exposed. The dura is opened by a crucial excision. Should hemorrhage present itself at this stage this is carefully evacuated. The underlying cortex is now inspected and the lateral cerebral fissure and the fissure of Rolando located. A thorough inspection of the cortex by means of a

brain spatula is now made, and discoloration, or other signs suggesting subcortical hemorrhage may or may not be present. Should these be present the next step is as follows (Figs. 3 and 4):

Step No. 5.—A hemorrhage is evacuated through the exploratory tract and gutta-percha drain carefully inserted through this tract to the hemorrhagic cavity. Should the cortex appear normal or, at least, only œdematous and show no signs of subcortical hemorrhage, an exploratory cerebrotomy is performed.

Step No. 6.—The opercular borders are drawn carefully apart just at, or anterior to, the points of intersection of the sylvian fissure and the projected Rolandic fissure. In the depths of this cleft the surface of the Island of Reil is located and a trochar is inserted therein for a distance of from one to three centimetres. This will penetrate the gray and white matter of the island, the claustrum, the putamen and the globus pallidus. It is in this region that one is likely to encounter free blood. Should this be encountered after one or several punctures the hemorrhagic cavity is treated in a manner exactly similar to the subcortical hemorrhage (Figs. 5, 6 and 7). (Ventricular puncture may be performed at this step, if necessary.)

Step No. 7.—The dura is folded back into place and not sutured.

Step No. 8.—The carefully guarded and uninjured edges of the temporal muscle are brought together with interrupted sutures of fine black silk. The temporal fascia is brought together in a similar manner. Several sutures are placed in the subcutaneous suture and the skin is brought together with interrupted fine black silk suture. The drain is led through the upper portion of this buffer (Fig. 8).

COMPLETE BRANCHIOGENIC FISTULA

BY CHARLES N. DOWD, M.D.

OF NEW YORK

SURGEON TO THE ROOSEVELT HOSPITAL

THE following diagram (Fig. 1), which is taken from McKenty's article,¹ suggests the general arrangement of the localities in which the different branchial arches develop.

The auditory canal develops at the site of the first cleft.^{2 3} The eustachian tube, the middle ear and the external auditory meatus would really form a complete fistula but for the membrana tympani which represents the thinnest portion of the cleft and contains two layers of epithelium, one from the ectoderm and one from the endoderm. This "near" fistula is really very similar to the real fistulæ which sometimes exist in the neck at the site of the second cleft. When maldevelopment at the first cleft occurs, it is apt to show itself by tabs in front of the ear, or defects in the ear itself, and occasionally is associated with defective formation of the mouth.

Figs. 2 and 3 illustrate this. They are photographs of a child in the Roosevelt Hospital and are similar to one figured by McKenty.

Maldevelopment at the site of the second cleft causes most of the branchiogenic anomalies which call for surgical care. These anomalies may consist of cysts, complete fistulæ, or blind fistulæ. The cysts lie in the side of the neck and are developed from sequestrations of branchial tissue. The complete fistulæ have internal openings near the tonsil and external openings at or near the anterior margin of the sternomastoid muscle somewhere between the hyoid bone and the clavicle. They are lined with epithelium, cylindrical at the inner end and squamous at the outer end. Their orifices are small. Their walls are composed of various kinds of tissue (see Fig. 5). The blind fistulæ are similarly constructed, but have single openings which may be either external or internal.

It has never been proved that complete fistulæ form either from the third or the fourth clefts (McKenty, Whitacre, König).

Complete fistulæ are not common. In looking over the records of

¹ F. E. McKenty: *Surgery, Gynæcology and Obstetrics*, August, 1914, vol. xix, p. 141.

² Whitacre: *ANNALS OF SURGERY*, vol. xxxvii, p. 62.

³ F. König: *Ueber Fistula colli congenita*. *Archiv f. klin. Chir.*, Bd. li, s. 578.

the New York Surgical Society one finds no report of such a fistula. This indicates the comparative rarity of the condition, although instances of it must have been observed by many members of the Society.

The patient here presented^{*} had such a fistula with well formed walls and with remarkably few adhesions to surrounding tissues. She was a healthy child of eleven years and showed no other evidence of congenital defect. Since infancy there had been a small opening at the inner margin of the right sternomastoid muscle one-half inch above the clavicle. The end of a small probe could be inserted into this opening and passed upward toward the pharynx. Colored fluid injected into it came through into the

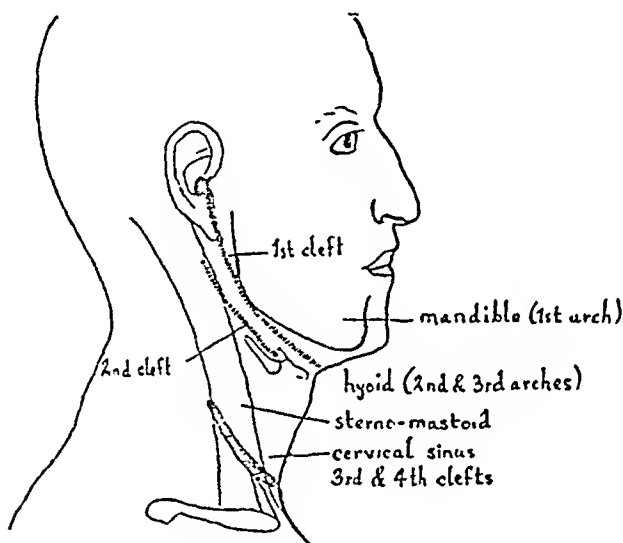


FIG. 1.—Localities in which branchial arches develop (McKenty).

mouth. Barium mixture injected into it showed on the X-ray plate a shadow of nearly uniform calibre, about one-eighth of an inch in diameter, running beside the trachea upward to the pharynx. The external opening was so small as hardly to be noticeable, but an annoying mucoid discharge came from it.

Operation.—On October 16, at the Roosevelt Hospital, under ether anaesthesia, a ureteral catheter was passed through the external opening upward to the region of the hyoid bone. An incision was then so made as to leave a disk of skin about the margin of the opening and to extend upward and backward nearly to the angle of the jaw. Flaps including the platysma were then separated on each side and the wall of the sinus was exposed to view—it lay on the deep fascia parallel to the sternohyoid muscle

^{*} Case presented to the New York Surgical Society, November 24, 1915.



FIGS. 2 and 3.—Photographs of child showing maldevelopment at the site of the first branchial cleft: defective ear, pre-auricular tabs, and defective mouth fissure.

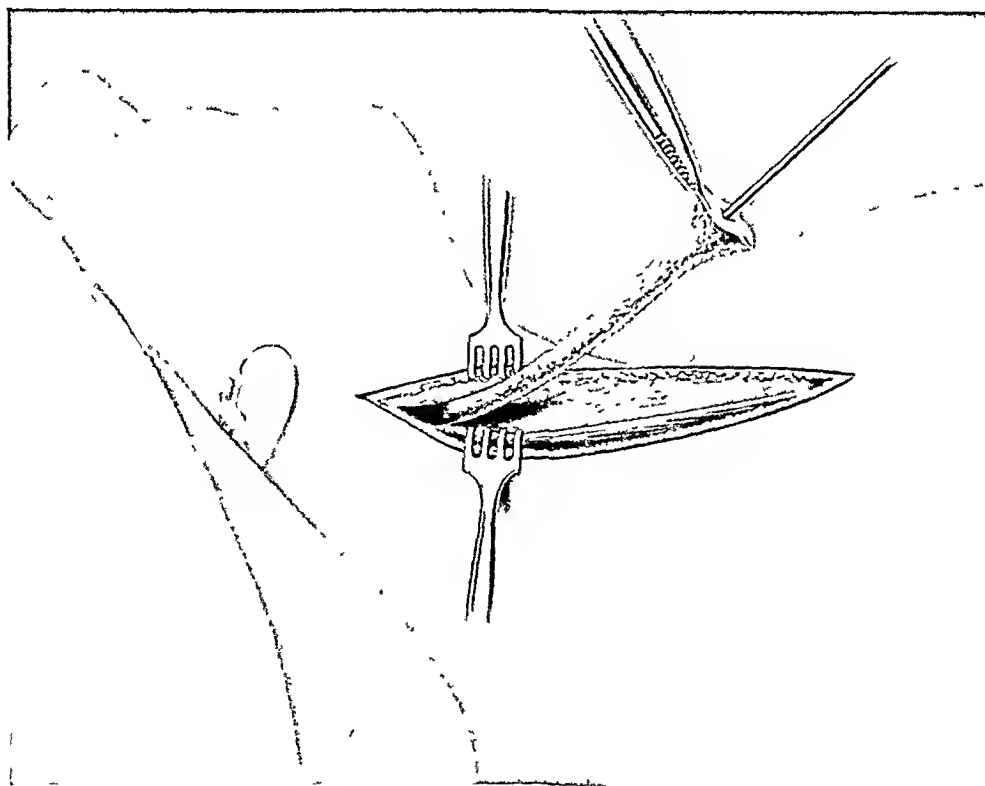


FIG. 4.—Sketch showing the appearance of the branchiogenic fistula during operation. The lower part of the wall of the fistula was easily separated from the deep fascia upon which it lay. When it was abducted a ureteral catheter passed easily through its lumen into the pharynx, close to the tonsil.



FIG. 2. Microphotograph of transverse section of wall of complete branchiogenic fistula near the entrance. A, luminal epithelium; B, lymph follicles; C, strands of unstriated muscle tissue; D, fat tissue; E, fat tissue; F, bundles of striped muscle.

and was astonishingly distinct. It resembled a large vein but was not dark colored. It was easily separated from the fascia as far upward as the hyoid bone and then presented the appearance shown in Fig. 4. When its lower end was abducted the ureteral catheter passed easily into the pharynx near the lower end of the tonsil. The upper part of the sinus wall was then separated from its attachments close up to the pharyngeal muscles. It passed beneath the anterior belly of the digastric muscle. Its attachments were so lax that neither the hypoglossal nor glosso-pharyngeal nerves were seen. The separation was so satisfactory that the inversion of the upper end of the tube into the pharynx seemed possible (as suggested by Von Hacker⁵). The fistulous tube was therefore cut off about three-quarters of an inch from the pharynx and a stitch taken in the distal end of the remnant and fastened to the catheter. The catheter was then withdrawn through the mouth and the end of the fistulous tube following it was inverted into the pharynx. It frayed away and separated at the margin of its pharyngeal opening. Its complete removal was therefore accomplished.

This procedure is, of course, the ideal one, since it completely removes the epithelium of the sinus and the embryonic wall which includes it. The procedure, however, is not always possible. Operation records show that there is considerable variation in these fistulæ. McKenty states that "if the development of the vessels be normal, a fistula of the second cleft must lie between the external and internal carotids." This corresponds to the embryology of the part, for the cleft lies between the embryonic external and internal carotid arteries. But the very existence of a fistula bespeaks abnormality and variations in position are not to be wondered at. Karewski⁶ and König⁷ have given very careful descriptions of some of these fistulæ and have found their walls densely adherent to the great vessels of the neck. It was impossible to dissect them away without destroying important neck structures—a procedure which the primary condition did not justify. A similar condition existed in a secondary case which the writer has operated upon. The sinus led to a conglomerate mass of tissue in the region of the carotid bifurcation.

On the other hand, Von Hacker and Whitacre have described cases similar to the one here reported. The sinus walls were loosely attached to the surrounding tissue and could easily be loosened well up to their

⁵ Von Hacker: *Centralblatt für Chirurgie*, 1897, p. 1073.

⁶ Karewski: *Virchow's Archives*, Bd. cxxxiii, p. 248.

⁷ König, F.: *Archiv für klin. Chirurgie*, Bd. lxx, p. 1009.

pharyngeal openings. In the writer's case the position of the external carotid artery was carefully noted. It was behind and not in front of the fistula and was not attached to its wall. Hence, we find that fistulæ with similar external and internal openings differ much in their median attachments and hence in the difficulty of their removal.

For the adherent cases, König has devised an ingenious method of treatment. He frees the distal end of the fistulous tube as far as he can and then passes this free end through the mucous membrane in front of the tonsil and stitches it there, thus leaving a curved sinus with an internal opening at each end—the posterior one pharyngeal; the anterior one buccal.

The structure of the walls of these fistulæ is complex and interesting. At the inner part they correspond to the pharyngeal structures, usually showing columnar epithelium, fibrous and areolar tissue, lymph follicles and strands of muscle tissue; a combination which harmonizes with their embryonic origin. At the outer part the epithelium is squamous and at the very end it blends into the structure of the skin. The wall of the outer part of the sinus is usually less developed than that of the inner part and contains no lymph follicles.

Fig. 5 represents a section of wall of this fistula near its inner end. Dr. Mortimer Warren, Pathologist of the Roosevelt Hospital, has reported upon it and has identified the structures as they are described beneath the figure. In a section taken near the external opening he found a lining of squamous epithelium surrounded by a wall of fibrous tissue which showed marked round-cell infiltration. This wall was less definitely formed than that of the inner end. It contained no lymph follicles.

THE SURGICAL TREATMENT OF SUPPURATIONS IN THE POSTERIOR MEDIASTINUM

BY VINCENT GAUDIANI, M.D.

OF NEW YORK

VISITING SURGEON, ITALIAN HOSPITAL

THE treatment of suppurations in the posterior mediastinum is still one of the most perplexing problems with reference to surgical technic. This is partly due to the relative difficulties of diagnosis for which patients are referred to the surgeon in a precarious state and to the seriousness of the operative procedures which have been advised. Two methods are known for opening and draining retromediastinal abscesses.

First, the dorsal mediastinotomy proposed and described by Nassilow in 1888.

Second, the cervical mediastinotomy (collar mediastinotomy, von Hacker).

As I had occasion, in my service, to treat surgically two cases of suppuration in the posterior mediastinum, I think it worth while to go into the history and literature of both operations.

The researches which Nassilow made on the cadaver had for their purpose not only the draining of purulent collections, but chiefly the performing of operations on the organs contained in the posterior mediastinum, as the removal of foreign bodies and the resection of the œsophagus. The importance of such operations, as Kocher states, is greatly diminished in view of the progress of endoscopic methods and development of anæsthesia under positive or negative pressure. The field of Nassilow's operation remains chiefly limited to the treatment of suppurations of whatever origin.

With the cadaver placed on the abdomen, Nassilow would diagram a musculocutaneous flap on the left side, which he dissected either centrally or laterally according to the place, high or low, where he performed the operation. After the resection of a few centimetres of the third-sixth ribs in the high operation or a few further down for the low operation, he dissected the pleura bluntly and penetrated deep into the mediastinum.

Quenu and Hartmann advised to perform the resection of the ribs not so near the columna. This can interfere with the view and work of the surgeon in penetrating on to the aorta and œsophagus. They made

their incision at the level of the angle of the ribs, and, by resecting two centimetres of the third, fourth and fifth ribs, could expose the hilus of the lungs and dominate the œsophagus down to the œsophageal opening in the diaphragm. In spite of the fact that the thoracic œsophagus is situated to the right of the columna, they insisted upon performing the operation on the left side on account of the special disposition of the pleura, which on the right forms a cul-de-sac behind the posterior wall of the œsophagus.

Potarca, with his work, tried to clear the question of the advisability of operating to the right or left side, and his decision concerning the advisability to operate to the right is based upon the left anatomical position of the aorta.

Bryant advised that when the operation was performed above the aorta, either the right or left side could be used, but that when the operation was performed lower down, the right side should be the side of choice.

Enderlen, after a careful discussion of the methods and a series of new researches, advised to operate (*a*) from the left when performed above the bifurcation of the bronchi, (*b*) from the right or left when performed at any point from the bifurcation of the bronchi to the diaphragm.

Heidenhain, contrary to Quenu and Hartmann and the others, recommends that the incision be made near the median line, that one or more of the transverse processes of the vertebræ be resected together with a portion of the ribs. At times the resection of a single process is sufficient to give a rather free entrance to the posterior mediastinum by a blunt dissection of the tissues along and anterior to the vertebræ. A wound of the pleura will very seldom occur.¹

¹ While performing dissection exercises in Rome (Italy), I had occasion several times to execute on the cadaver, the Fontan-Ménard operation for the drainage of the vertebral bodies. As both the incision and the first step of the operation on laminae and ribs are almost identical to the Heidenhain's operation, I used to expose by such method the organs contained in the posterior mediastinum. By following the vertebral bodies, after two or three laminae and nearly 1½ inches of the adjoining ribs had been resected, one could very easily dissect the pleura and have a fair view of the organs.

Such a personal experience enables me to prefer the Heidenhain technic, if I had to operate for an abscess in the posterior mediastinum, through the posterior route. I consider that the relative disadvantages, namely, the going through a thick muscular layer, the rather difficult resection of the laminae and costovertebral joint, are balanced by the safer and easier dissection of the pleura. This, of course, is very important in operating for a suppurative case.

SUPPURATIONS IN THE POSTERIOR MEDIASTINUM

These anatomico-surgical considerations are indeed of great weight when the opening of the posterior mediastinum has for its purpose the performing of some operation on the œsophagus or bronchi. When the operation has for its purpose the evacuation of pus, then it is not necessary to expose the organs contained therein and when this is the case, either way, depending upon circumstances, may be used.

Cervical mediastinotomy has not gained a standing as the result of either operations or researches, but because of the fact that a number of cases have been successfully treated by the cervical route. Details of the technic are of secondary importance compared to the review of the few cases concerning the anatomical findings revealed either by operations or autopsies. As can be seen by the following short reports, the cases operated upon by way of the neck are not many.

The oldest one recorded is that of Lürmann:

CASE I.—A deep abscess of the left side of the neck developed as the result of an attack of pharyngeal angina. When the fluctuation was evident, Lürmann incised over the anterior border of the sternocleidomastoid and obtained about one pint of foul-smelling pus. Through the opening in the neck, the chest could be explored deeply by means of a sound. The cavity could be filled with nearly two quarts of liquid, which was verified by percussing the back. Two weeks after the operation food appeared in the wound. Patient made a slow but uneventful recovery.

CASE II (Ziembiecki).—Started with a sudden pain in the neck and dysphagic symptoms. During the first few days an œsophageal sound could be passed. General symptoms: fever, fetid breath, peculiar configuration of the neck, as an increase in size without œdema, pharyngeal and laryngeal congestion.

Diagnosis.—Prevertebral septic phlegmon.

Operation.—Incision, as to perform external œsophagotomy. Collection of pus underneath the deep fascia, from which a cavity extended for twelve centimetres between the œsophagus and vertebræ, in which a piece of bone was found. Patient was fed with an œsophageal tube throughout his stay in the hospital. Was discharged with wound almost healed but with a small œsophageal fistula. The patient having begun to take food per os, returned to the hospital with a new abscess of the posterior mediastinum. An operation on the dorsal mediastinum was proposed but refused. Patient died after three months. The autopsy revealed a small fistula in the posterior wall of the œsophagus a little below the pharynx. The abscess, which had denuded and eroded the bodies of the cervical and dorsal vertebræ, extended about twelve centimetres into the chest. Purulent pleurisy and gangrene of the right pulmonary apex was found.

CASE III (Obalinski).—Patient 21 years old. After being unable to swallow anything for three days, a painful swelling appeared on the right inferior side. Temperature, 39.5° C.; pulse, 120. Œsophageal sounds could not be passed. The swollen mass was incised and pus was easily evacuated. Death occurred after a few hours. A post-mortem typical operation on the posterior mediastinum revealed an abscess in the chest which had not been drained.

VINCENT GAUDIANI

CASE IV (Heidenhain).—Patient had swallowed a piece of bone. Could not state whether the bone had passed or not. For fourteen days had pain over the supraclavicular groove and painful deglutition. For the last four days, even fluids could not be swallowed. There was rigidity of the back. Radiating pains on the right side of the chest. Cough, high temperature. Transverse arcuate incision over the right supraclavicular region; sternocleidomastoid tendon severed. Retraction of the vessels so as to expose the œsophagus. The surgeon penetrated bluntly into the retro-œsophageal tissues. An abscess with necrotic tissues was found and opened, which extended nearly ten centimetres into the chest. Recovered in four weeks.

CASE V (Rasumowski).—Patient was a boy of 12 years, who had sustained a gunshot wound of the neck. The bullet penetrated from the left side above with a downward course, through the presternal muscles, thyroid gland, into the chest. At the operation an abscess was opened which extended for 15 cm. into the posterior mediastinum. The abscess was seen to communicate with the trachea through a small opening. Patient was kept in the Trendelenburg position during the after-treatment. Patient was fed through tube for the nine ensuing months. Recovery was uneventful.

CASE VI (Von Hacker).—Symptoms of peri-œsophageal suppuration appeared after œsophagoscopy. Gastrostomy was performed first. After this, abscess was opened with an incision along the anterior border of the sternocleidomastoid. Death occurred after six days.

CASE VII (Von Hacker).—Perforation of œsophagus in its thoracic portion from sounding. Retrosternal pain appeared soon after. The day after, patient had difficulty in breathing and swelling at the base of the neck, which swelling was neither emphysematous nor fluctuating in character. Cutaneous emphysema appeared in 24 hours. Operation as in above case. The cavity, which contained pus and gas, extended from the posterior mediastinum to the retrosternal region. The trachea and œsophagus were retracted to the left side. After three days an œsophageal fistula appeared which healed in fourteen days. The abscess was drained for months in the Trendelenburg position. A gastrostomy had been performed in advance in order to feed the patient.

CASE VIII (Cavazzani).—In this case a cervical operation was at first performed. After three months, in order that a better drainage might be effected, a dorsal mediastinotomy was done on the left side. An œsophageal fistula was also present in this case.

PERSONAL CASES

CASE IX.—A. Faravino, admitted to the Italian Hospital May 23, 1913. Discharged June 1, 1913. Man of 62 years, suffering from diabetes. Condition started 25 days ago with pain on left side of neck and difficulty in swallowing. Gradually became worse until only fluids could be swallowed.

Physical State.—A swollen mass was felt at the base of the neck. The left sternocleidomastoid was made prominent by a mass which appeared anterior, and was fluctuating in character. Temperature 102°.

Operation.—Under local anæsthesia, a three-inch incision was



FIG 1 —Radiograph of Case X, taken just before operation

SUPPURATIONS IN THE POSTERIOR MEDIASTINUM

made along the anterior border of the sternocleidomastoid. A considerable amount of pus and necrotic tissue was found and evacuated from under the deep fascia. After this had been done, and the cavity cleared, said cavity seemed to extend behind the œsophagus as far down as a finger could explore. A drain of from six to seven inches long was necessary to reach the most dependent portion. The œsophagus appeared normal in every respect except that it was completely separated from the anterior surface of the vertebræ. A counter-opening along the posterior margin of the sternocleidomastoid was effected and large rubber drains were inserted, after which the patient was placed in the Trendelenburg position for several days. The day after operation he could swallow freely and he began to expectorate a blood-tinged sputum. Patient was discharged with a clean, granulating wound and was treated at his home by the house physician, Dr. Petillo. Wound healed in about two months. Died a year after operation from diabetes.

CASE X.—P. De Girolamo, age 40 years. Admitted to the Italian Hospital, July 17, 1915. A week before admission patient swallowed a small fishbone which imbedded itself into the upper part of the œsophagus. After a few days, dysphagic symptoms appeared and during the last few days only fluids could be swallowed. Temperature on admission 102°.

Physical State.—A well-built man, muscular and robust. Base of neck symmetrically enlarged on both sides with signs of stasis in the veins of both head and neck. Palpation over both supraclavicular fossæ, painful. Passage of a stomach tube impossible.

Blood count: Total white count, 8050. Differential of 200 cells: Polymorphonuclears, 79 per cent.; small lymphocytes, 18 per cent.; large lymphocytes, 2 per cent.; eosinophiles, 1 per cent.

Laryngoscopic examination: Negative.²

Ice-bag was kept on neck continuously. Chill at 2 A.M. of next day, lasting 15 minutes.

July 19, afternoon: Condition worse. Base of neck very much enlarged, painful to both deep and superficial palpation. Increased stasis and cyanosis of both face and neck. Breathing normal.

Blood count: Total white count, 8000. Differential of 200 cells: Polymorphonuclears, 80 per cent.; small lymphocytes, 17 per cent.; large lymphocytes, 2 per cent.; eosinophiles, 1 per cent.

Examination of heart and lungs did not reveal anything.

Maximum temperature, 102°.

X-ray examination: The mediastinal shadow has considerably increased in size and lost the normal conical shape (Fig. 1).

² Performed by Dr. Baldereschi, who kindly referred the case to me.

Operation.—July 19, 4.30 P.M., 1915, nearly 48 hours after admission. After anæsthetizing the part with novocaine-suprarenin, an incision was made over the anterior margin of the sternocleidomastoid, as for the typical exposure of the œsophagus. As soon as the skin and subcutaneous tissues were cut, patient became cyanotic and symptoms of sudden asphyxia arose. After provisory clamping of blood-vessels and covering the wound, a low tracheotomy was performed. As soon as this was done, fetid mucus escaped from the wound. A tracheal cannula was inserted and general anæsthesia was given through same. Then the interrupted operation was resumed as follows: The œdematous œsophagus was rather easily recognized and exposed. The carotid artery was separated and retracted externally, while the left lobe of the thyroid gland was elevated. With the œsophagus clearly in sight, the posterior mediastinum was penetrated by blunt dissection. As soon as the Kocher dissector was introduced behind the œsophagus, a stream of fetid pus appeared, which was rapidly aspirated by suction. The small opening was further enlarged downward until three fingers could freely penetrate a large cavity, the bottom of which could be sounded by a Pool's sucker. With my fingers introduced I could follow the œsophagus and feel the pulsation of a very large vessel (arch of the aorta). On examining the cervical œsophagus, a small purulent spot (about size of the head of a pin) could be seen on its external side and one inch below the pharynx. Iodoform gauze drainage effected, with patient in the Trendelenburg position.

On the 20th, at 2 A.M., the temperature reached 106° F., pulse 140, and respiration 32. At 2.30 P.M. of the same day the dressing was changed. The tracheal cannula was removed and the wound cleaned with peroxide. Patient could swallow freely, no fluid coming through the œsophagus. The condition became worse as night approached, when the temperature reached 107°, pulse 166 and respiration 44. Patient died at 7.45 A.M., of the 21st July.

Autopsy by Coroner's physician (Weinberg).

After the lungs had been removed, a cavity which reached as far down as the arch of the aorta was exposed the wall of which was covered with necrotic tissue but entirely free from pus. Lungs showed a diffuse bronchopneumonia. Upon opening the larynx and trachea, there could be seen a diffuse necrosis of the mucosa which extended down the bronchi. On the posterior wall of the trachea, nearly one inch under the cricoid cartilage, a small ulcerative perforation was found which allowed of entrance of a probe. The mucosa lining the œsophagus was apparently normal.

SUPPURATIONS IN THE POSTERIOR MEDIASTINUM

It can be seen that my two cases do not both belong to the same class. The first case showed a chronic type with severe local, but very mild general symptoms, and case two was characterized by both very severe local and general symptoms. In Case I the object of the operation was to drain an abscess which gave symptoms of pressure of the œsophagus and which I thought was located under the deep cervical fascia. Only the operation (as in the cases of Lürmann, Rasumowski and Obalinski) revealed the existence of a retro-mediastinal cavity.

In Case II a correct diagnosis was made before operation. Therefore I had in mind, as in the other cases above reported, to reach the focus, through the cervical route (collar mediastinotomie, Von Hacker).

The origin of the abscesses in both these cases was very probably from the œsophagus, although neither operation nor autopsy gave proof that this was the case. In Case I a bloody expectoration appeared as soon as the abscess was opened, indicating very probably an ulceration of the œsophagus.

In Case II the patient gave a history of having swallowed a very small fishbone a week before admission. At operation a small abscess was found on the exterior coat of the œsophagus, one and one-half inches below the trachea on the left side. Although no trace of the lesion was found in the mucosa at autopsy, it is fair to assume that a tiny fishbone migrated through it into the posterior mediastinum.

That the opening in the trachea in Case II was a secondary occurrence seems to me more than certain, inasmuch as the primary and successive symptoms were only of a dysphagic nature. No symptoms of dyspnœa were present until a little before operation and no trace of the foul odor which we perceived when the trachea was opened had until then been perceptible. The cause of death was due to an acute bronchopneumonia *ab ingestis*. In Case I, which was under my care for two weeks, I was prepared to drain the abscess from the dorsal route, having been instructed by the Cavazzani case, but this proved to be unnecessary.

Altogether, the cases of abscesses in the posterior mediastinum reported in the medical literature, in which a cervical operation was performed, with my two new ones, are ten, including the Cavazzani case, in which a dorsal operation was performed months after the cervical.

Five cases (Lürmann, Rasumowski, Von Hacker, Heidenhain, Gaudiani) were cured by the cervical operation. One (Cavazzani) was cured by the cervical plus the dorsal operation. One (Ziembiecki) can be considered among the cured, as the patient died when already

in a very good condition—started to swallow food through the mouth, instead of through the œsophageal tube. One can say that seven times out of ten, cervical mediastinotomy was successful, applied in the treatment of abscesses in the posterior mediastinum. If we do not consider among the unsuccessful cases the Ziembiecki case, we find three deaths. In all these cases the operation had reached and drained the pus cavity. In all three, the general condition, on account of the sepsis, was exceedingly bad, so that the posterior operation would have certainly hastened the fatal result. As I have already stated, it is probable that in my case the cause of death was due to pneumonia and this due to the opening of the abscess in the trachea a little before the operation was performed. Therefore the clinical experience does not justify what Ziembiecki, as a result of his case, proposes: *that indiscriminately in each case a cervical and dorsal operation must be performed*, as this appeared to be necessary only in the Cavazzani case, while in all the rest the cervical operation was sufficient and in a few the dorsal route could not have helped at all.

There is no question but that in many cases the cervical incision may not allow of a successful drainage, but even then such an operation may cause the acute septic symptoms to disappear, do away with their sequelæ, and give time for a better localization of the cavity and the place where to perform the dorsal operation.

There are no special details in the operative technic to be described. In the majority of cases an incision as for the exposure of the cervical œsophagus is performed. The œdema or emphysema of the superficial tissues may make the operation more difficult. When the œsophagus is widely exposed, the vessels of the neck are strongly retracted laterally while the thyroid gland, which may be in the way, is elevated. Care must be taken not to injure the arteria thyroidea inferior. By blunt dissection, the œsophagus is separated from the bodies of the vertebræ and a way is easily found leading into the posterior mediastinum.

Heidenhain performed such an operation with a transverse incision. In one of my cases, two incisions were used, one anterior to and the other posterior to the sternocleidomastoid to insure of better drainage. The Trendelenburg position for several days and aspirative drainage are very valuable.

Another technical point is how to deal with œsophageal perforations. The performing of a gastrostomy in every case, as advised by Von Hacker, cannot be accepted, as sometimes a perforation of the œsophagus does not exist, even when the abscess had its origin from

SUPPURATIONS IN THE POSTERIOR MEDIASTINUM

that organ. Gastrostomy could prove to be in several cases an unnecessary procedure in an already weak patient. Therefore I think it wise to drain the abscess without paying any attention to the possible lesions of the œsophagus, unless an actual perforation appears in the operative field. In such a case, an œsophageal tube must be introduced through which the patient can be fed. Afterward, one may decide whether it is better to perform a gastrostomy or to continue feeding through the tube until the healing of the abscess has occurred. When no real lesion of the œsophagus is noticed at the operation, the wound is carefully watched for the appearance of food, in which case, according to circumstances, a gastrostomy or œsophagostomy is performed.

CONCLUSIONS

Abscesses in the posterior mediastinum must be treated by incision through the dorsal or cervical route.

All abscesses located at any point in the posterior mediastinum may be dealt with by the dorsal incision, but its real indication is for cavities located low in the mediastinum below the arch of the aorta from the fourth to fifth dorsal down.

All abscesses situated at the level or above the fourth dorsal may be successfully opened and drained through a cervical incision. Only secondarily a dorsal mediastinotomy may be necessary.

Cervical mediastinotomy has a rather wide range, principally because of the fact that many abscesses have their origin from the superior portion of the œsophagus or from the retro-pharyngeal space and only secondarily migrate in the chest.

Abscesses whose origins are in the superior part of the mediastinum have, according to Von Hacker, no tendency to spread downward. Because of the lessened density of the cellular tissue above the heart, they easily migrate toward the neck.

LITERATURE

- Bryant: Transactions of American Surgical Association, 1895.
Cavazzani: Ascesso del mediastino posteriore diagnosticato e operato con toracotomia dorsale. *Riforma medica*, 1898.
Enderlen: Ein Beitrag zur Chirurgie des hinteren Mediastinum. *Deutsche Zeitschrift für Chirurgie*, Bd. 61.
Heidenhain: Über einen Fall von Mediastinitis suppurativa posterior. *Arch. für klinische Chir.*, 1899, Bd. 59.
Lürmann: Ein Fall von Œsophagus-fistel mit secundärer Bildung eines Mediastinalabscesses. *Berliner Klin. Wochenschrift*, 1876, No. 9.
Kocher: *Chirurgische Operationslehre*, 5th Auflage.
Nassilow: Referred in W. Levy: Versuche über die Resection der Speiseröhre. *Archiv für klin. Chirurgie*, Bd. LVI.

VINCENT GAUDIANI

- Obalinski: Beitrag zur operativen Behandlung des hinteren Brustfellraumes.
Wiener Klin. Wochenschrift, 1896.
- Quenu et Hartmann: Bulletin et Mémoires de la Société de Chirurgie de Paris.
Tome XVII.
- Rasumowski: Hildebrandt's Jahresbericht für 1900, p. 411.
- Von Hacker: Zur operativen Behandlung der perioesophagealen und mediastinalen Phlegmone nebst Bemerkungen der collaren und dorsalen Mediastinotomie. Arch für klinische Chirurgie, Bd. 64.
- Ziembiecki: Du phlegmon du mediastin posterieur. 1895. Referred in Potarca.
La chirurgie intermediastinique posterieure. Paris, 1898.

REMOVAL OF BULLET FROM PERICARDIUM

REPORT OF A CASE

BY WILLIAM E. LOWER, M.D.

OF CLEVELAND, OHIO

(From Service of Lakeside Unit, American Ambulance at Neuilly-sur-Seine, Paris, France)

ON November 1, a French Zouave, while advancing with his company in a crouching position to take a block-house, was hit by a rifle ball which entered about 4 cm. to the left of the first dorsal vertebra. The impact knocked him down; he expectorated some blood, and, after remaining on the ground until the assault was over, he worked his way back to the trench. He suffered little or no pain. He was taken to the Field Hospital where he was retained for some time, and was afterward transferred to a Base Hospital, where an X-ray picture was taken which showed the bullet in the same shadow with the heart. Fluoroscopic examination disclosed that every time the heart beat the bullet moved with it.

The wound at the point of entrance healed readily and the patient suffered no great discomfort, the hemorrhage from the lungs ceasing after a few days.

He was admitted to the American Ambulance Hospital of Paris, February 17, 1915, about three and one-half months after being wounded. At the time he came under our observation, examination showed a well-nourished young man, twenty-one years of age, with a healed wound in the back. Patient was in no pain, his chief complaint being that when walking or exercising he quickly became fatigued and experienced shortness of breath.

A second X-ray examination showed the shadow of the bullet lying near the apex of the heart and pointing upward and inward (Fig. 1). Fluoroscopic examination showed the bullet moving in a rotary manner with each heart-beat. The patient's temperature was 99, his pulse 90. It seemed that the position of the bullet was responsible for the dyspnoea and that in some way it was mechanically interfering with the heart's action. After keeping him under observation for a week, I decided to attempt the removal of the bullet.

Operation.—Under nitrous-oxide-oxygen anæsthesia, a rectangular flap was made, as shown in the cut (Fig. 2, *A*). The skin together with the muscles was dissected free from the ribs and the flap turned outward (Fig. 2, *B*). The vertical incision extended from the attachment of the fourth rib to that of the sixth and seventh ribs. The fourth, fifth and sixth ribs were cut at the cartilaginous attachment (Fig. 2, *C*) and the intercostal muscles

divided midway between the fourth and fifth ribs (Fig. 2, *D*). Then by careful dissection the ribs were elevated, exposing the internal mammary artery which was not cut. By retraction the pleura and pericardium underneath were exposed, the exposure being quite ample for further manipulation (Fig. 2, *F*). By palpation I was then able to detect the bullet, the point of which had passed through the pericardium, the base apparently lying just outside. The bullet moved freely with each heart-beat. It was impossible to tell how deeply it had penetrated the muscle of the heart, but it did not seem as though it had gone deep enough to enter the left ventricle. The tissues on either side of the bullet were grasped with forceps to steady it sufficiently to make an incision, and then a cut was made over the base of the bullet. The bullet was then grasped with hæmostatic forceps and removed. It was well encysted and no hemorrhage followed its removal.

It did not seem advisable to make any further exploration or to try to suture over the opening. A small amount of old, washed-out blood escaped with the bullet. In elevating the ribs the pleura was opened and there was a collapse of the lung, but little disturbance resulted from this. There was practically no hemorrhage in the whole operation. The intercostal arteries were not disturbed nor was the internal mammary in danger. The intercostal muscles were sutured with mattress sutures of chromic catgut and the cartilage was sutured to the sternum by single ties (Fig. 2, *G*). The cartilaginous ends were sewed with chromic catgut and were easily held in place. A small cigarette drain was placed in the wound for drainage in the event of oozing.

After two days the patient developed a pneumonia on the right side and had a rather stormy time for a few days. Later, when the left lung began to expand, a similar condition began on the left side and this was followed by effusion which later necessitated the resection of a rib and drainage. He rapidly recovered from this and made a complete recovery.

On May 3, I had a letter from him, enclosing a photograph showing that he was up and about, and except for a small sinus was in good condition.

The principal feature to which I wish to call attention is the method of approach which was made in this case; that is, the division of the cartilaginous attachment to the ribs and of the muscles between the ribs, so as to make, by retraction, a "V" exposure. By this method ample room is secured and the ribs are not fractured, a circumstance which retards convalescence and makes it much more painful. With this exposure it would have been quite possible to have done any further work which might have been necessary on the heart muscle itself.



FIG. 1.—X-ray photograph showing shadow of bullet lying in the apex of the heart.

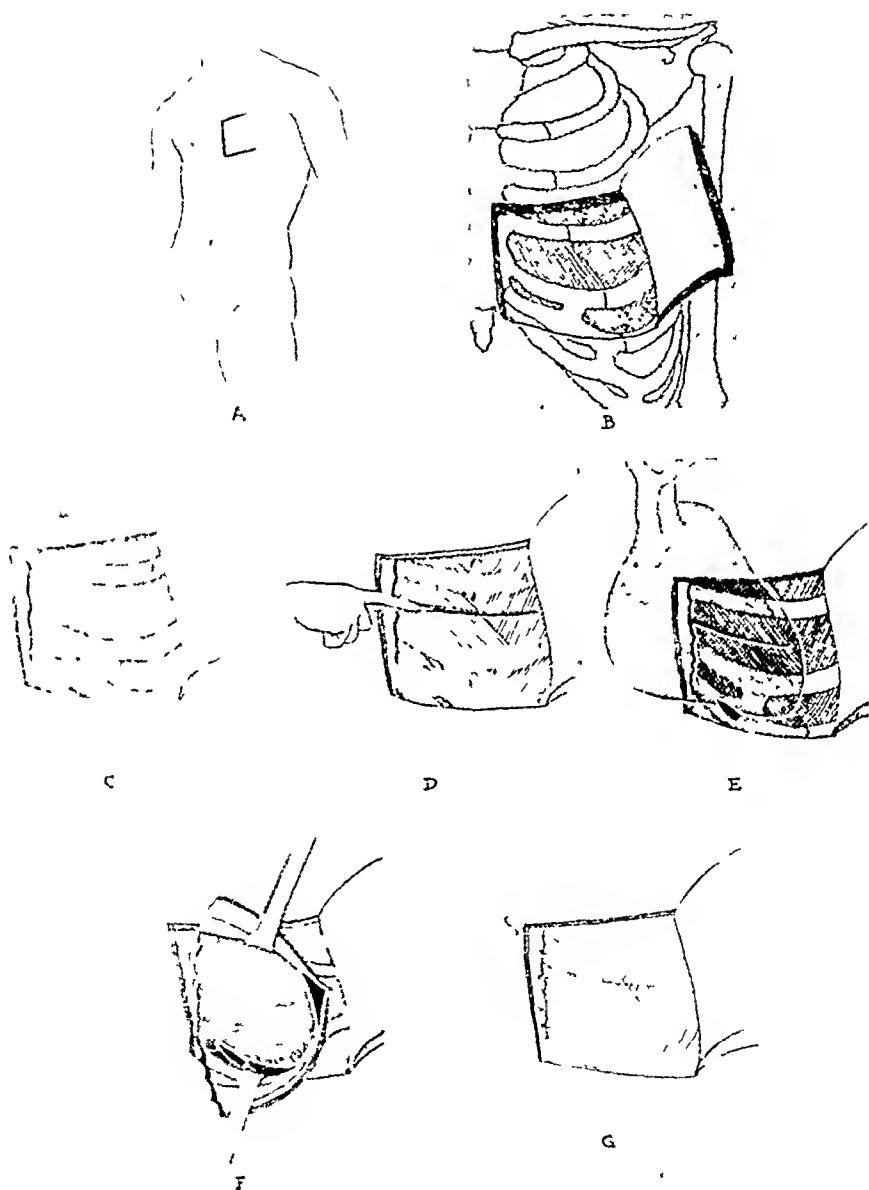


Fig. 1. Diagrams illustrating various steps in the operation for the removal of bullet from pericardium.

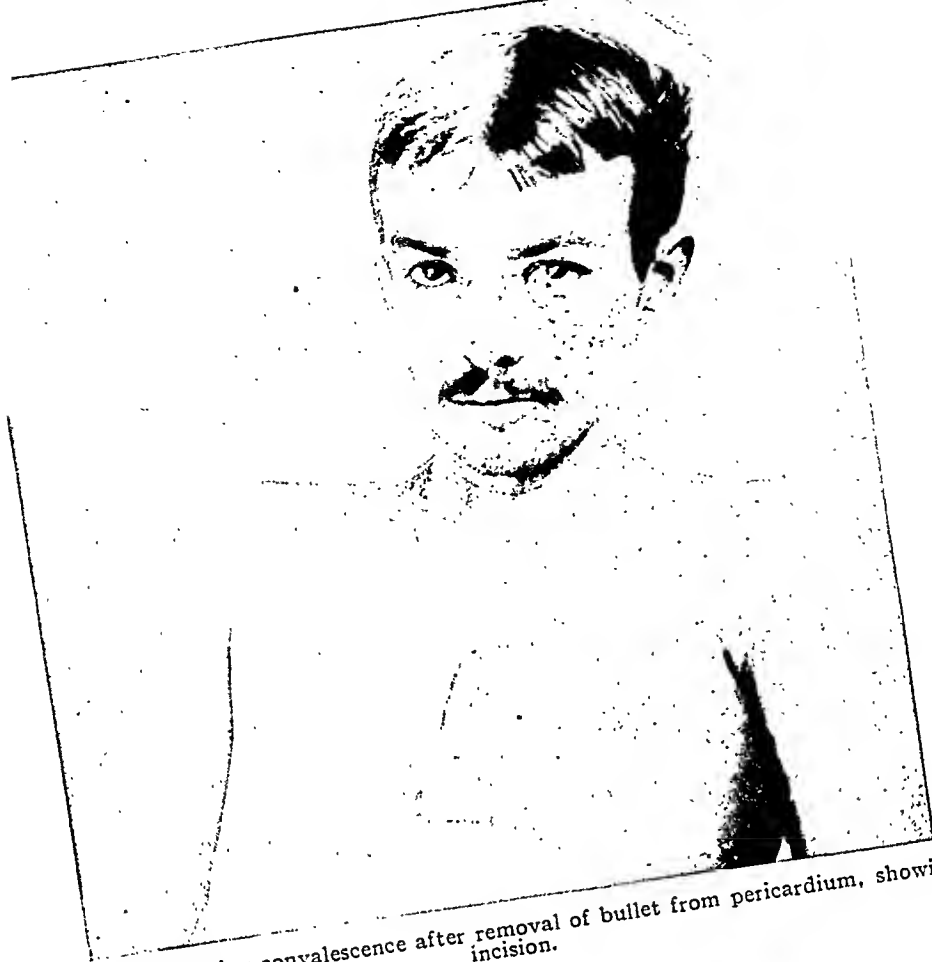


FIG. 3.—Patient during convalescence after removal of bullet from pericardium, showing line of incision.



FIG. 4.—Patient after recovery from operation for removal of bullet from pericardium.

INTRAHEPATIC CHOLELITHIASIS

By RICHARD LEWISOHN, M.D.

OF NEW YORK CITY

(From the Surgical Service of Beth Israel Hospital)

INTRAHEPATIC cholelithiasis, *i.e.*, accumulation of stones in the main branches of the hepatic ducts and in its ramifications, is a well-known and not extremely rare finding in the dissecting room. The medical literature comprises about 250 cases of this disease. Beer, in 1904, published a very thorough study of this condition. He dissected 250 livers of patients who had died of gall-stone diseases and found intra-hepatic cholelithiasis in 6 cases (about 2.5 per cent.). It is most surprising that in our modern era of operative surgery, comprising every year innumerable operations on the biliary system, a typical case of intrahepatic cholelithiasis has never been reported from an operating room. The only possible explanation for this condition of affairs is that the disease, on account of its rarity, was not properly diagnosed by the surgeon.

I had the rare occasion to operate upon a case of intrahepatic cholelithiasis in which I could make the diagnosis on the operating table. This case presents a surgical unicum, and I think that its rarity warrants a rather detailed report.

S. R., thirty-one years of age, tailor, was admitted to the Beth Israel Hospital on November 19, 1914.

Family History.—Negative.

Previous History.—Patient had typhoid fever sixteen years ago and an attack of jaundice fourteen years ago. He has been perfectly well since that time.

Present Illness.—One day before admission to the hospital the patient was seized with abdominal cramps. These pains lasted about three hours and were referred to the shoulder. He had nausea and vomited twice.

At 11.30 this morning, while walking, he was again seized with abdominal cramps, also referred to the right shoulder. The pain is continuous. He had a chill lasting three-quarters of an hour, felt feverish, did not vomit.

Physical Examination.—Marked tenderness about one inch below the right costal margin. Peritoneal irritation elicited on

right side of abdomen. Tenderness at McBurney's point. Marked rigidity on the right side of abdomen, less on left side.

We were evidently dealing with an acute inflammatory process in the right hypochondrium.

Pre-operative Diagnosis.—Acute gangrenous cholecystitis or perforated duodenal ulcer.

Operation (November 19, 1914) (Lewisohn).—Right rectus incision three inches long. On opening the abdominal cavity a gush of turbid, yellow fluid escaped from the upper abdomen. The amount of free fluid was rather large. The gall-bladder was distended to about twice its normal size, not tense; its walls were thin and showed no external signs of inflammation. The stomach protruded through the incision and was so distended that a stomach tube was passed to expose the field; the stomach contained a large amount of clear fluid. The stomach itself was normal and a careful examination of the duodenum failed to show any sign of ulcer or perforation. There was a moderate amount of fresh fibrin around the stomach.

The liver was enlarged to about one and one-half times its normal size and showed extensive adhesions between the upper surface and the diaphragm; this surface was covered with a large amount of fresh fibrin, and on separating the adhesions a moderate amount of turbid yellow fluid escaped from between the two surfaces. The whole diaphragmatic surface of the liver felt nodular; these areas were hard, some of them whitish in color. On the inferior surface of the liver, toward the anterior border, there was a markedly inflamed area belonging to the right lobe; in this part was seen a small abscess cavity, which had perforated and opened into the free peritoneal cavity. At the base of the cavity two small gall-stones were felt; the liver tissue was incised, and the stones removed (Fig. 1). Wound sutured with chromic gut (two sutures). The stones were small and black in color. The site from which they were removed was more than an inch and a half away from the attachment of the gall-bladder to its left.

The nodular diaphragmatic surface of the liver was then exposed, and one of these nodules on the right lobe, about four inches from the anterior free border, was incised; after splitting the capsule, a small hard nodule presented itself, about the size of a pea; the mass was whitish and hard (fibrous tissue?). From the centre of this mass four small, black gall-stones were removed. They were exactly like those which had been found on the under surface of the liver (Figs. 2 and 3).

A strip of gauze was inserted in this region and one to the abscess cavity on the inferior surface.

The gall-bladder was opened. It contained about thirty cubic



FIG. 1.—Perforation of intrahepatic stones at under surface of the liver, causing a localized peritonitis.

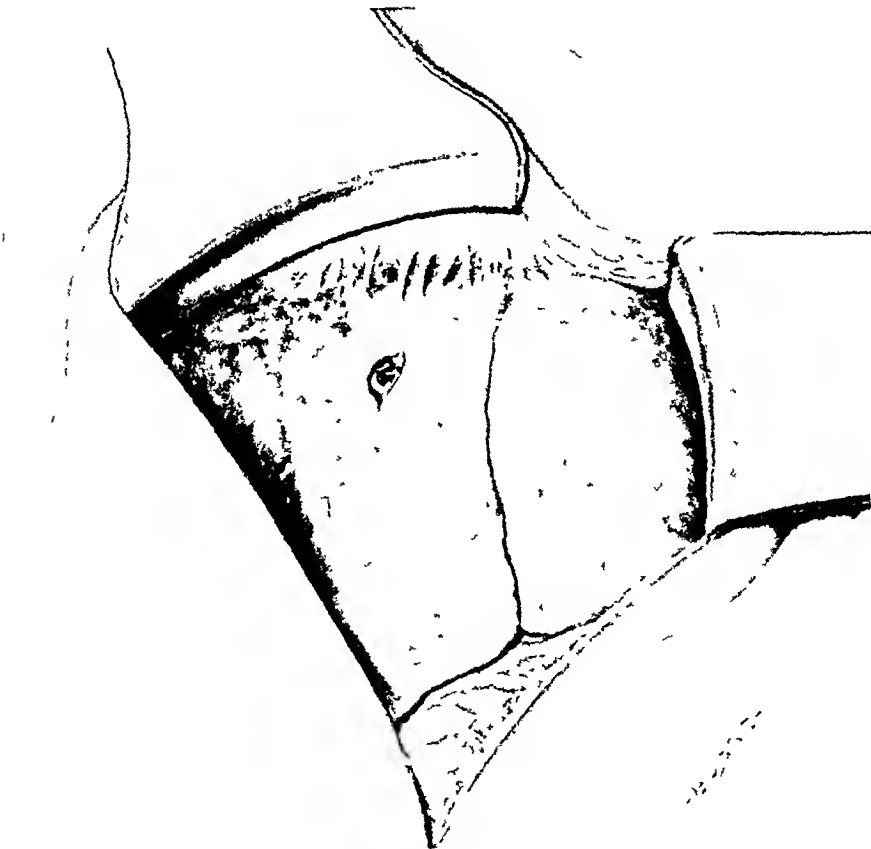


FIG. 2.—Removal of intrahepatic stones from diaphragmatic surface of the liver.

INTRAHEPATIC CHOLELITHIASIS

centimetres of a turbid fluid and one-half dozen yellowish gall-stones. The yellowish color of these gall-stones differed markedly from the black color of the intrahepatic stones. The mucosa was only slightly inflamed and not thickened. Rubber tube sutured into gall-bladder with plain gut.

Abdominal incision closed, through-and-through sutures of chromic gut being used, and a space left for the tube and gauze drains; skin closed with silk.

A careful examination of the bile ducts was not possible on account of the poor condition of the patient.

Post-operative Diagnosis.—Intrahepatic cholelithiasis; spon-

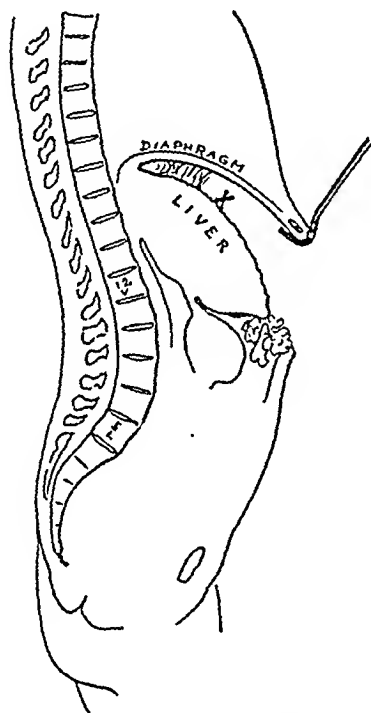


FIG. 3.—Diagrammatic side view. X, removal of intrahepatic stones from the diaphragmatic surface of the liver.

taneous perforation of intrahepatic stones at the under surface of the liver, causing a localized peritonitis.

The post-operative course during the first week was uneventful. From the seventh day a profuse biliary discharge set in. The stools were acholic. This complete biliary fistula lasted for about six weeks. Later the stools began to show normal color and the discharge from the biliary fistula was considerably less. The patient left the hospital on February 5, 1915. The biliary fistula persisted until September, 1915, and then closed spontaneously. For the last four months the patient has been apparently in perfect health and attends regularly to his business.

Dr. S. Bookman, Chief of the Department of Physiological

Chemistry, of Mount Sinai Hospital, was kind enough to examine the intrahepatic stones. He reported the following findings: Weight 2-3 mgm.; chemical construction: fatty acids, cholesterin (48.11 per cent.), and bile pigments. No phosphate, calcium or magnesium.

The high percentage of cholesterin in these stones is rather uncommon. Most of the intrahepatic stones reported in the literature consisted mainly of bilirubin-calcium.

The intrahepatic stones were black, very irregular in shape and non-faceted. The stones removed from the gall-bladder showed a light greenish color and had a smooth surface (typical facets).

The surgical literature of intrahepatic calculi is a very small one; it comprises only two cases (Hawkes and Noguchi). Noguchi removed a solitary stone from a patient thirty-four years of age, from the hilus of the liver. The stone had a diameter of one and one-half centimetres. Noguchi reports that the exposure of the operative field was by no means satisfactory. It seems to me very doubtful whether Noguchi's interpretation of this case (solitary intrahepatic stone) is a correct one. It is very possible, that he was dealing with a solitary stone in the cystic duct which had perforated into the surrounding tissue, where it became encapsulated. The gall-bladder was not removed in this case.

Hawkes reports a very interesting case:

The patient had been operated on two years previously for cholelithiasis; a cholecystectomy had been done. The symptoms recurred and the X-ray showed some shadows; these were interpreted as being caused by several calculi. Exploratory laparotomy: Upon passing the hand upward toward the dome of the liver on the right side, a number of calculi were found imbedded in the liver substance about four inches from the free bed of the liver. The calculi were situated about one-quarter of an inch from the capsule of the liver in a mass of hardened tissue. It was thought wise not to remove these calculi at once on account of the danger from biliary leakage, there being no adhesions at this point. For the promotion of adhesions sterile gauze packings were introduced to the area occupied by the calculi. Four days later the calculi were removed by an incision through the liver substance. Three calculous masses were dug out with the index finger from the indurated tissues surrounding them. The stones numbered twelve, varying in size from $\frac{1}{16}$ to $\frac{1}{8}$ inch in diameter. The patient made an uneventful recovery.

Hawkes's patient undoubtedly was a case of removal of intrahepatic stones. The case, however, does not present quite as typical an appearance as my case reported above, and the typical cases of intrahepatic cholelithiasis found rather frequently in the dissecting room. There is no evidence that in Hawkes's case the stones were disseminated

INTRAHEPATIC CHOLELITHIASIS

through the whole biliary system of the liver. The surface of the liver (except for the one place where the conglomeration of stones was found) was smooth and there was no such evidence of an intrahepatic stone formation through the entire liver as in my case.

Beer has pointed out that three different etiological factors have to be considered for the formation of intrahepatic stones; first, obstruction; second, cholangitis; and third, an unknown factor (diathesis?). Obstruction and cholangitis alone cannot explain the picture of intrahepatic cholelithiasis. For intrahepatic stones are, as a rule, not found in complete obstruction of the common duct by a tumor at Vater's papilla, though a secondary cholangitis is very often present in these cases. We must therefore assume a third factor which causes the formation of intrahepatic stones.

A vast literature has accumulated on the subject of the formation of gall-stones. It would, however, go far beyond the scope of this paper to review the innumerable publications on this subject. Frerichs, Thudichum and Courvoisier claimed that the stagnation of bile was the cause for the formation of intrahepatic stones. Naunyn claimed that bacteria wandering into the biliary system caused an oxidation of bile and secondary formation of gall-stones.

Mignot has made extensive experimental studies which seem to support Naunyn's views. He introduced cotton pledgets saturated with emulsions of attenuated cultures of bacterium coli into the gall-bladder and thus caused after five months the formation of stones. The introduction of aseptic foreign bodies into the gall-bladder did not produce any stones. Miyake arrived independently at the same conclusion.

The question of the formation of intrahepatic stones is of the greatest interest to the surgeon. Every surgeon will experience cases where, after a previous cholecystectomy and a thorough removal of common duct stones, he has to reoperate on account of jaundice. At the second operation, he again finds stones in the common duct. The question then arises: Were these stones overlooked at the first operation?

There can be no doubt that such findings are not necessarily due to a faulty technic. It is possible that intrahepatic stones, formed in the finer ramifications of the hepatic ducts, have wandered down into the common duct and have thus produced a recurrence of symptoms.

A great deal of discussion has been caused by the question whether intrahepatic stones are formed in the liver or whether they are formed in the gall-bladder and have later wandered upward into the liver. Beer has already pointed out that the intrahepatic stones differ entirely in shape, color and character from the stones found in the gall-bladder,

and that it is therefore impossible to assume that the intrahepatic stones had originally been formed in the gall-bladder. The findings in my case confirm this view. The stones removed from the hepatic ducts differ absolutely from those removed from the gall-bladder. Furthermore, in Lenhartz's case (Fig. 4), one of the most typical cases of intrahepatic cholelithiasis, the gall-bladder did not contain any stones. It is therefore beyond doubt, that intrahepatic stones can be and are formed in the liver.

The divergence between the rather frequent cases of intrahepatic cholelithiasis in the dissecting room and the rarity of this condition in clinical surgery can be explained by the fact that the condition is easily overlooked on the operating table. As a rule, the surgeon who finds stones in the gall-bladder is satisfied to remove the stones either by cholecystostomy or cholecystectomy. He does not inspect the liver very carefully and thus misses the proper diagnosis which requires a very thorough examination.

The interesting points which induced me to report this case are:

1. The extreme rarity of this condition in surgical pathology.
2. The fact that this is the first case in which intrahepatic stones had perforated, thus causing a localized peritonitis.
3. The interesting observation that a biliary fistula which persisted for eight months, closed spontaneously (and has remained closed for four months), though the hepatic ducts, and very probably the common duct, are filled with stones.

LITERATURE

¹ Beer: *Med. News*, 1904, lxxxv.

² Courvoisier: *Casuistische-Statistische Beitr. z. Path. u. Chir. d. Gallenwege*, 1890.

³ Hawkes: *Reports Presbyterian Hosp.*, 1906, vii.

⁴ Lenhartz: *Die sept. Erkrankungen*, Nothnagel's Handbueh, etc.

⁵ Mignot: *Bull. et mém. de la soc. de chir. de Paris*, xxiv.

⁶ Miyake: *Mitth. aus d. Grenzgb. d. Med. u. Chir.*, 1900, vi.

⁷ Naunyn: *Klinik der Cholelithiasis*, 1891.

⁸ Noguchi: *Arch. f. klin. Chir.*, 1911, xcvi.

⁹ Thudichum: *Treatise on Gall-stones*, 1863.

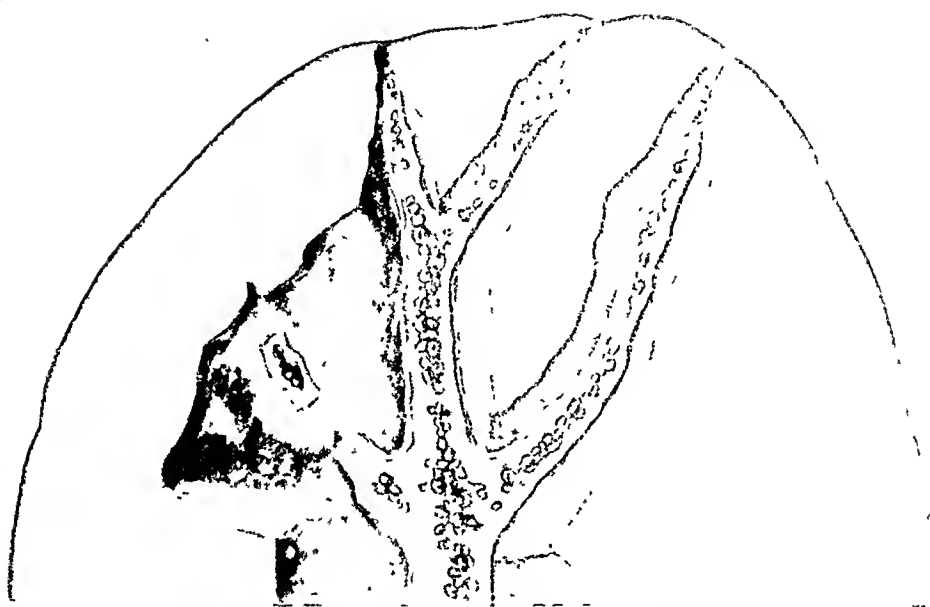


FIG. 4.—Post-mortem specimen illustrating intrahepatic cholelithiasis (Lenhartz).

A METHOD OF CORRECTING THE STOMACH DILATATION IN GASTROPTOSIS

BY R. J. BEHAN, M.D.

OF PITTSBURG, PA.

SURGEON, ST. JOSEPH'S HOSPITAL

IN the correction of an enlarged and dilated stomach the aim heretofore has been to support the stomach in such a manner that its fundus is raised so that the greater curvature would be nearly on a level with the pylorus, and consequently permit of better drainage. The methods previously devised consisted of shortening the gastrohepatic ligament, of attaching the omentum to the anterior abdominal wall, or of attaching the stomach to the anterior abdominal wall by means of adhesions.

The surgical principle of all these methods seems to be wrong in

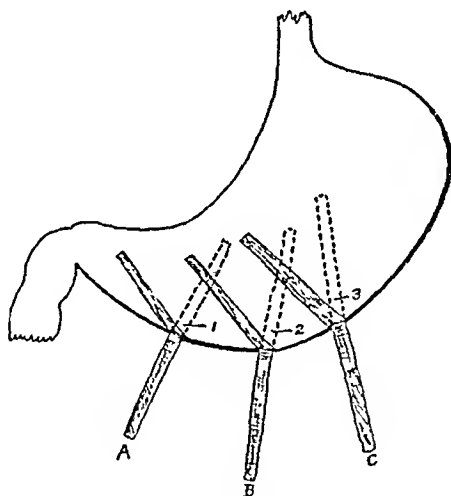


FIG. 1.—The method of making the flaps of serosa. The dotted lines indicate the direction of the tunnels and the manner in which they run under the serosa.

that the pathological state (the atony) causing the end lesion is not corrected; only the end lesion (the ptosis) itself is affected. Two of the end results of a gastroptosis are gastric dilatation and an abnormally low position of the stomach. Both of these act in a vicious circle, for because of the ptosis the pylorus is kinked and consequently food and drink entering the stomach will not easily be extruded, and will act as additional inciting factors to a further dilatation and ptosis.

The surgical corrective principle would be either to decrease the

size of the stomach or in some manner to render it functionally more active. The first of these is accomplished by the operation I have devised. The second will follow as a result of the first.

To test the harmlessness of decreasing the size of the stomach I performed an operation embodying these principles on a dog, and the results were remarkably good. The description of the method follows:

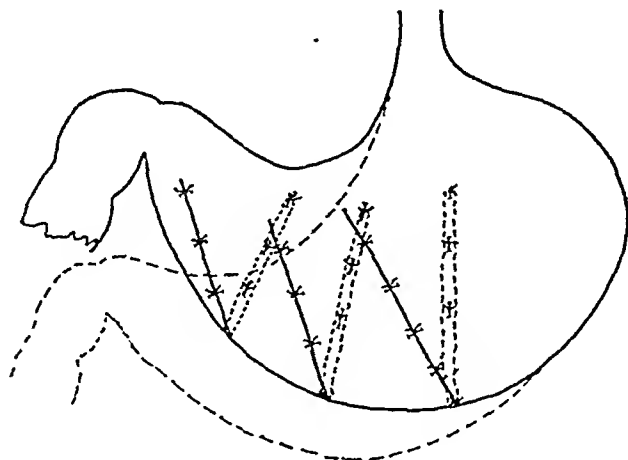


FIG. 2.—The flaps have been drawn through the tunnels. The sutures have been placed.

Dog Operation.—Abdomen opened. Stomach exposed and a flap of serosa was freed from its anterior surface. The flap ($\frac{1}{2}$ inch wide) extended from the lesser curvature downward obliquely toward the greater curvature and fundus

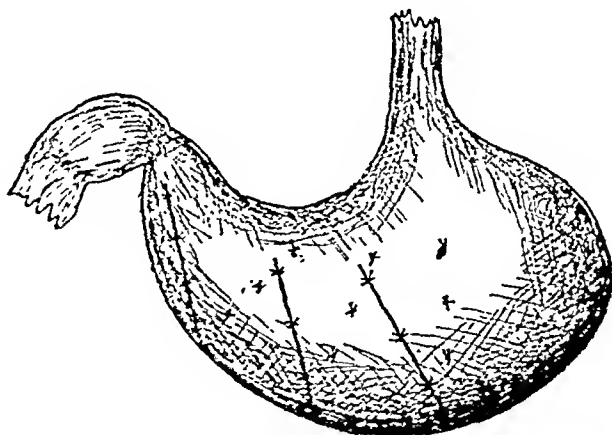


FIG. 3.—Operation has been completed. Figure does not show the plication in the gastrohepatic omentum, which is also necessary to bring the stomach up into its normal position.

for about 3 to 4 inches (Fig. 1.). This flap was then inserted in a reversed direction through two flaps raised from the subjacent muscularis (Fig. 2). The flap was then sutured in place. The raw surface was puckered in (Fig. 3) and the wound closed.



FIG. 4.—The stomach before it was opened. The stomach is seen in its normal position. It is to be noted that the omentum is drawn up to a considerable extent on the greater curvature of the stomach (C), thus narrowing the lumen to the same degree. Adherent to the stomach is the greater omentum which, because of certain later operative procedures, the abdominal cavity is seen to be very full. The contractive power of the stomach must have been excellent, as a considerable amount of food is seen to be present with difficulty through the pylorus. The gastrohepatic omentum is seen to be very large.

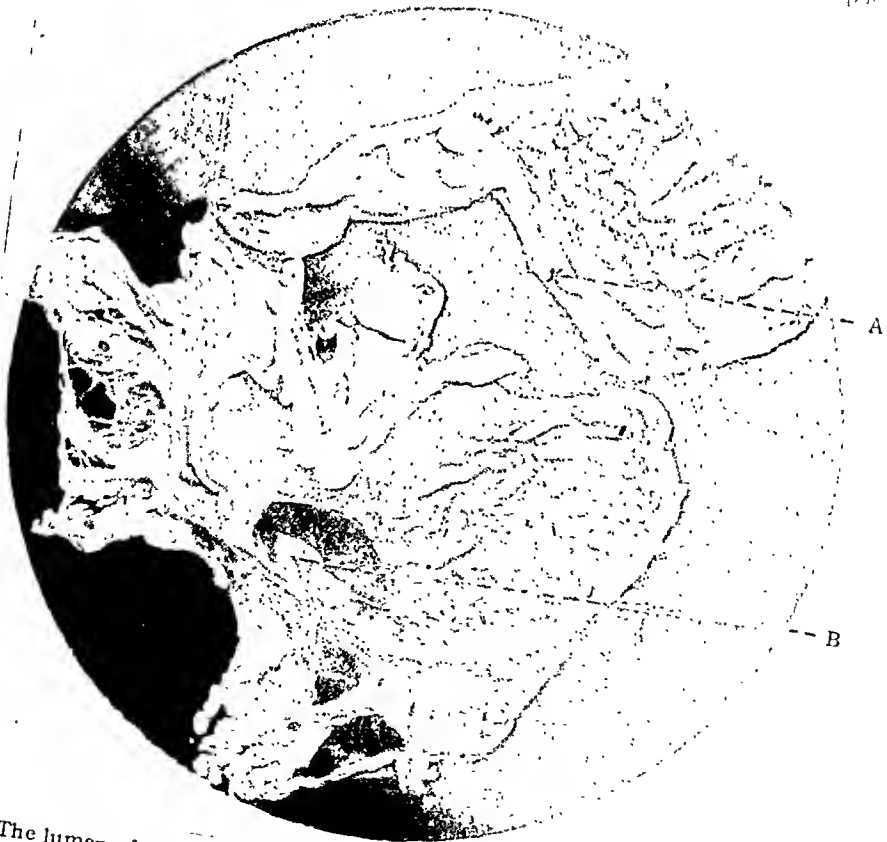


FIG. 5.—The lumen of the stomach with its rugæ is exposed. The large ruga (B) anterior to the black paper on the greater curvature is due to the redundancy of mucous membrane due to the contraction of the wall. At A is seen the thickened wall consisting of the muscularis. The rugæ seem to be absolutely normal in appearance.

STOMACH DILATATION IN GASTROPTOSIS

February 21: The dog was very active and frisky, extremely playful. Incision O. K.

March 23: Abdominal incision. The area of stomach operated showed a scar somewhat T-shaped. No adhesions. Stomach much smaller than at time of first operation. At the time of the first operation the lower border of the greater curvature extended a considerable distance below the liver margin. At the present the lower border extends only a very short distance below it.

On December 12, 1915, the dog was killed, and the stomach removed. It was remarkably decreased in size. On the anterior surface is seen the scar resulting from the operation. On examining the internal surface of the stomach the rugæ are apparently not disturbed over the area operated. On examining the wall it is seen that at the area of operation there is a very long ruga which projects into the lumen of the stomach. The wall is greatly thickened.

The specimen shows that after the plication the muscle contracted and threw the mucosa into deeper folds. Thus the same area of mucous surface is exposed so that the food comes into direct contact with the same extent of mucous membrane. To sight and touch the gastric muscle is absolutely normal.

Whether this method would act as well in a dilated stomach remains to be proven. It is not dangerous. It is planned on physiologic principles, and the stomach functionates perfectly after its adoption. However, in man it might be necessary at the same time to plicate and thus shorten the gastrohepatic ligament.

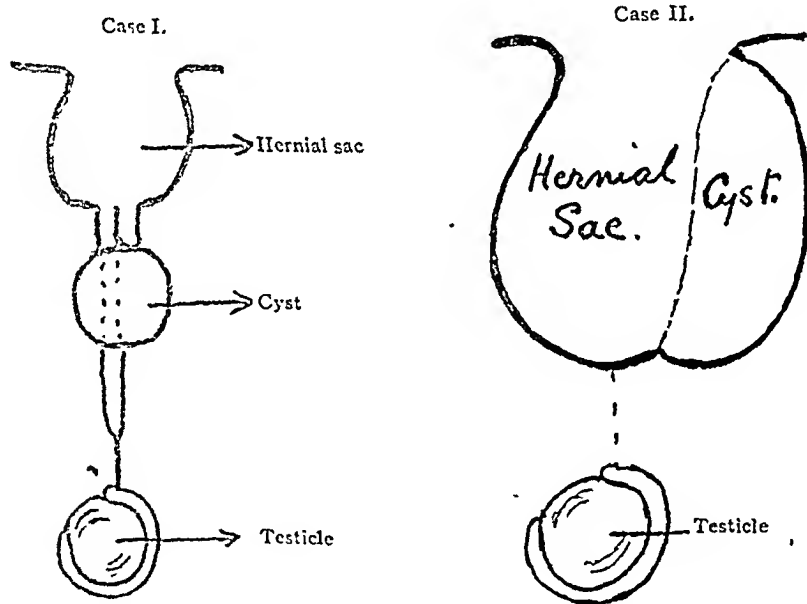
NOTE.—Since the above went to press I have used this method on two patients and so far the results have been very satisfactory.

THE ETIOLOGY OF CYSTS CONNECTED WITH HERNIAL SACS

BY R. W. MURRAY, F.R.C.S.

OF LIVERPOOL, ENGLAND

ANY surgeon who has had occasion to perform a large number of operations for the radical cure of inguinal hernia must, from time to time, have met with anomalous conditions of the sac and its connections which are difficult to account for satisfactorily. This has been my experience, and I will exemplify my meaning by referring to two cases, and at the same time venture to offer an explanation of the state of affairs found at the operation.



In one case the patient was a young man suffering with a "hydrocele of the cord." At the operation a small hernial sac was found, and connected with the fundus of the sac was the peculiar and complicated condition depicted in the accompanying diagram.

Attached to the fundus of the sac were two patent funicular processes, each of which opened into the sac. At the blind end of the shorter process was a tense cyst, one inch in length, which contained clear fluid. The longer process had a uniform lumen and passed downward behind the cyst, to which it was intimately adherent. The lower end of this process was connected with the

CYSTS CONNECTED WITH HERNIAL SACS

tunica vaginalis by a fibrous cord, so that it was undoubtedly the remains of the true processus vaginalis testis.

The other case was that of an adult male who was admitted to hospital for the cure of a scrotal hernia which had existed for many years and could not be reduced satisfactorily. At the operation a large cyst, which contained clear fluid, was found lying upon and intimately adherent to the anterior surface of the sac wall. The relative size and relation of the cyst to the hernial sac are illustrated here.

Though the origin of these two cysts may at first sight appear to have nothing in common and be difficult to account for, their presence can, I believe, be readily explained on the views advanced many years ago by Mr. Lockwood regarding the etiology of infantile hernia. Mr. Lockwood pointed out that if the processus vaginalis is drawn down by the gubernaculum, a second sac of peritoneum might be produced by the traction of some additional fibres of the gubernaculum in a manner entirely analogous to that which produced the processus vaginalis testis.

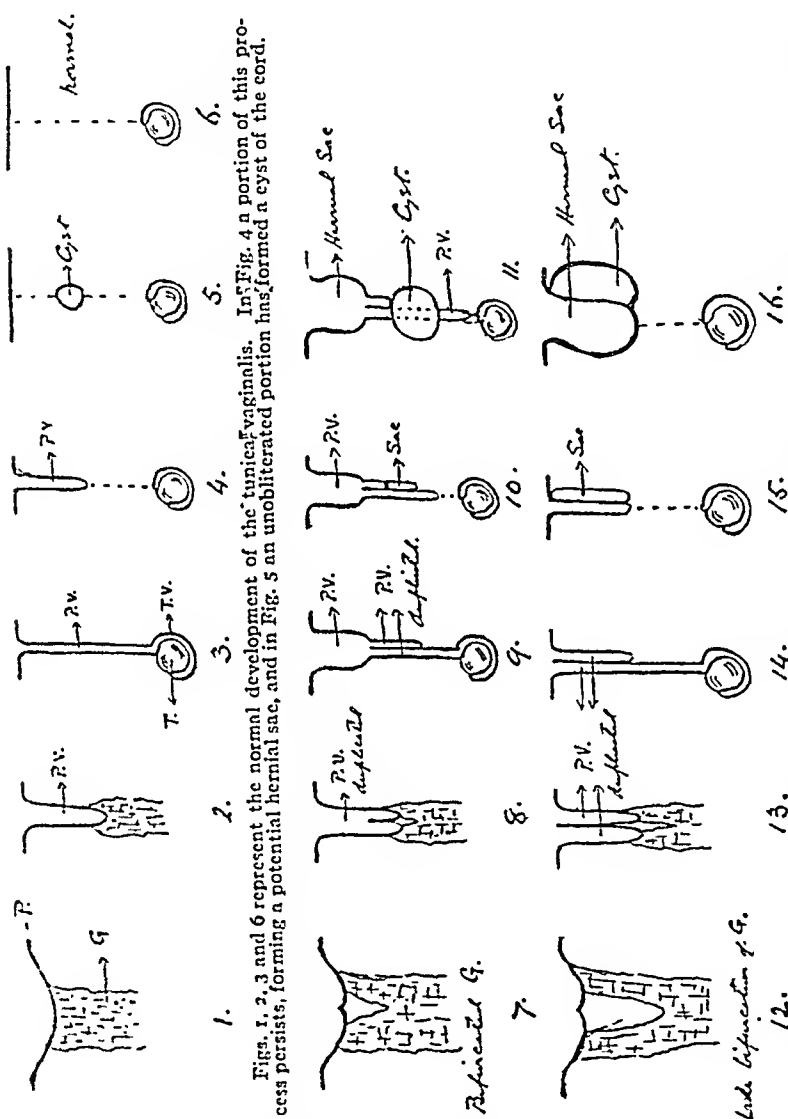
It is a well-known fact that the obliteration of the processus vaginalis is frequently imperfect and often takes place in an irregular manner. The most common defect is for the upper part of this process to remain patent, thus forming a potential hernial sac. The whole of the funicular process may remain patent, or only the upper and lower ends may become obliterated, thus resulting in a cystic distention of the unobliterated part.

Many other irregularities have been observed, but I merely wish to emphasize the fact that obliteration may fail to occur at any point in the whole length of the process from the tunica vaginalis to the internal abdominal ring.

In the Figs. 1 to 6 I have represented diagrammatically how the tunica vaginalis is formed, and some of the more common developmental defects.

Bearing these facts in mind let us see how the anomalous condition found in the two cases I have mentioned can be accounted for. The chief difficulty in the first case is to explain the presence of two funicular processes attached to the fundus of a hernia sac. As the gubernaculum is responsible for the normal descent of a process of peritoneum to the bottom of the scrotum, it is reasonable to suppose, as Mr. Lockwood was the first to suggest, that if this process is duplicated the gubernaculum must have something to do with it, for there is no other structure that could perform a similar function.

In the first case the peritoneal attachment of the gubernaculum must have been bifurcated, and consequently two peritoneal processes instead of a single one were pulled through the inguinal canal toward the scrotum (Figs. 7 and 8). It should be noticed that the duplication of the funicular process is not complete, for the division does not extend



Figs. 1, 2, 3 and 6 represent the normal development of the tunica vaginalis. In Fig. 4 a portion of this process persists, forming a potential hemal sac, and in Fig. 5 an unobliterated portion has formed a cyst of the cord.

Figs. 7 to 16 represent a duplication of the processus vaginalis owing to an irregular attachment of the gubernaculum to the peritoneum. The imperfect and irregular obliteration of these peritoneal processes accounts for the state of affairs illustrated by Figs. 11 and 16. G, gubernaculum; P, peritoneum; P. V., processus vaginalis. T, testis; T. V., tunica vaginalis.

up to the level of the internal abdominal ring. As the duplication is not complete it is probable that the peritoneal attachments of the gubernaculum were not widely separated, and its contraction caused the funicular process to have two nipple-like terminations. The subsequent changes are not difficult to account for, and are depicted in Figs.

CYSTS CONNECTED WITH HERNIAL SACS

9 and 11. The longer process, after forming the tunica vaginalis, became obliterated at its lower part, the upper part remaining patent. The shorter process became obliterated about its middle, thus forming a closed sac below, and remained patent above (Fig. 10). The bowel descended into the large single diverticulum into which both these processes opened, thus converting it into a hernial sac; and fluid accumulating in the small closed sac, a cyst was formed.

In the second case I believe the developmental irregularities were very similar to those I have just described. In this case, however, the duplication of the processus vaginalis must have been more complete, extending up to the level of the internal abdominal ring. This I would account for by a wider bifurcation of the peritoneal attachment of the gubernaculum than in the other case, consequently two complete and separate processes of peritoneum were drawn through the inguinal canals (Figs. 12 and 13). The lower half of the longer process—the true processus vaginalis testis—became obliterated after forming the tunica vaginalis, the upper half remaining patent. The upper part of the shorter process became obliterated, thus forming a closed sac (Figs. 14 and 15). Bowel entering the patent diverticulum converted it into a hernial sac; and fluid accumulating in the closed sac made it a cyst. All these changes are represented diagrammatically in the accompanying figures.

In conclusion, I would submit that as the gubernaculum is undoubtedly responsible for the presence of the peritoneal diverticulum known as the processus vaginalis testis, circumstantial evidence is strongly in favor of the view that if this process is found to be duplicated, then this second diverticulum must be due to a duplication of the force which produced the first. If this premise is correct, then the subsequent irregular obliteration of these processes clearly accounts for the anomalous conditions I have described.

LUMBAR HERNIA *

BY EDWARD H. GOODMAN, M.D.

AND

JOHN SPEESE, M.D.

OF PHILADELPHIA

HERNIA in the lumbar region is one of the rare varieties and may occur as a congenital affection, as a spontaneous or acquired form, or as the result of severe local injuries or diminished local resistance following infectious processes. In reporting an instance of spontaneous or acquired hernia, we have thought it desirable to review the literature on the subject, as there is considerable uncertainty as to what constitutes a true lumbar hernia. We have studied, therefore, the instances of congenital and acquired hernia and have excluded from our statistics those hernias following direct traumatism of any type, and those the result of local inflammatory processes, both of which have been instrumental in causing a fairly large number of the cases on record. We have found reports of 33 cases of acquired lumbar hernia, 11 of congenital lumbar hernia, and about 40 cases following local injury and disease.

The entire subject of lumbar hernia is attended with much interest from the historical stand-point. We have consulted Jeannel's article freely for the descriptions of the cases reported by the first writers on this subject.

In Pierre Franco's *Traité des Hernies*, published in 1561, nothing is said of hernia other than inguinal, and it is not until a century later (1672 or 1687) that we find what seems to be the first description of lumbar hernia. Paul Barbette at this time states that, "Experience has taught me that the peritoneum may rupture in its posterior aspect toward the back, thus forming a hernia." Stephen Blancard, in 1701, states only, "Peritoneum prope spinam dorsi ruptum dat herniam"; a laconism which suggests the possibility of a lumbar hernia but does not permit of the supposition that the author had seen a case.

Dolée (1703) knew of lumbar hernia, but he, like his predecessors, took no pains to study its anatomy or its mechanism, although later writers without quoting Dolée correctly have interpreted him as describing lumbar hernia. Jeannel emphatically states that there occurs no passage in Dolée's writings to warrant this, and he reproduces verbatim the Latin text, which is without any special interest. Budgeon, in 1728,

* Read before the Philadelphia Academy of Surgery, December 6, 1915.

LUMBAR HERNIA

described a case of congenital hernia, but it is apparent that he had no idea of the true nature of the condition.

The first trustworthy observation on record is that of Garangeot (1731), who mentions a case of strangulated hernia, reducible after death, perhaps at the expense of a ruptured intestine. Although Garangeot made no autopsy, there can be little doubt about the true nature of the case. The report made by Garangeot failed to stimulate the interest of his contemporaries, for Arnaud (1749), although knowing that hernias may present themselves in the back, forbears to say more, as such hernias, "far from instructing those for whom I write, may prevent one from comprehending ordinary hernias." "*Étrange prétexte ou plutôt mauvaise excuse de l'ignorance de l'auteur*," is the comment of Jeannel.

Ravaton, in 1750, published the first case of strangulated lumbar hernia which was cured by operation, but details are lacking as to the exact location of the tumor. A decade later Hermann (1767) described a case of strangulated hernia which was cured spontaneously by the formation of an artificial anus. In 1768, Balin writes, "Lumbar hernia may arise unexpectedly between the false ribs and the crest of the ilium, at the point where the external oblique is attached only by a cellular tissue." Although this is brief, terribly laconic, according to Jeannel, the latter claims that Petit, to whom is given the credit for describing the triangle which bears his name, has written no more fully. Jeannel discredits Petit (1774), and claims that in his article he has not described the triangle in question, has not furnished us with any anatomical data concerning his case, and Jeannel confesses he is at a loss to know why this region is called "Petit's triangle" any more than by the name of Dolée, Garangeot, Ravaton or Balin, who wrote as fully about it as did Petit. This view, it may be mentioned, is shared by Larrey also.

Since Petit's time no one until the advent of Grynfeldt attempted any serious study on the subject, and the term lumbar hernia was used so loosely that ventral hernias were continually being confused with the lumbar variety (Plenck, Chopart and Desault, Callison).

Grynfeldt (1866) was the first to give the subject deep thought, and described the space which bears his name. "The aponeurotic fibres of the transversalis in dividing form a passage for the lower intercostal artery, just as the spermatic cord enters the two pillars of the external ring. There is at this site a natural point of lessened resistance. If the lower border of the internal oblique inclines more anteriorly than normally, the last intercostal artery perforates the aponeurosis of the transversalis above the border. In other words, if the point of re-

sistance of this artery is in the lumbo-costo-abdominal triangle all the conditions favoring a hernia are realized." The space of Grynfeltt is bounded above by the twelfth rib, internally by the quadratus lumborum, externally by the external oblique and below by the internal oblique muscle.

Four years later Lesshaft (1870), without mentioning Grynfeltt's work, came to the same conclusions and the space is known in Germany as Lesshaft's triangle, but its proper name should be the Grynfeltt-Lesshaft space. Lesshaft studied 108 adult cadavers, and found Petit's triangle present in 84. In 34 cadavers of embryos or new-born the structure was present 9 times. In other words, the triangle is generally present in adults and only occasionally in embryos or the new-born. When the triangle was not present it was noted that the edge of the latissimus dorsi muscle was in direct apposition with or overlapped the margin of the external oblique. The importance of the triangle was emphasized by these studies, as it is more constantly present and is larger than the inferior triangle of Petit.

V. Baracz and Bursynski have in turn made anatomical studies with the following results: After the first layer of the back muscles is turned aside (latissimus dorsi) one sees the second layer, consisting of the posterior inferior serratus muscle and the internal oblique. Between these two may be seen the third layer, the aponeurotic portion of the transversalis. This muscle with the lower border of the serratus posticus inferior, together with the inner edge of the twelfth rib above, the erector spinalis, the internal oblique and the external oblique laterally, and the base composed of the transversalis, make up the triangle lumbo-costo-abdominal of Grynfeltt and Lesshaft.

The authors have made numerous dissections, having reference to Petit's triangle and to the triangle of Grynfeltt, and of 76 examinations, Petit's triangle was missing 12 times on both sides and 4 times on one side only. It existed, then, in 63.13 per cent. of the cases. The size of the triangle varies a great deal, often merely a slit and again having a base 5 or 6 cm. wide. The base may be muscle alone (internal oblique) or muscle and tendon where the internal oblique extends to the lateral base of the erector spinalis. To pierce this layer great force was necessary, and as there are no openings for the vessels or nerves, the authors consider it improbable that a hernia can rise through Petit's triangle.

The Grynfeltt-Lesshaft triangle was present in 93.5 per cent. of the dissections, and the authors regard it as an almost constantly occurring weakness in the lumbar region. The space is not always that of a triangle or rhombus, it may be deltoid, trapezoid or polyhedral. The

LUMBAR HERNIA

shape and size of the triangle depend on several factors: the length of the twelfth rib, whether the internal oblique with its muscle bundles reaches to the lateral border of the erector spinæ, or is in varying distance therefrom forming a tendinous aponeurosis; upon the development of the serratus posticus inferior; upon whether the fibres of the median border of the external oblique insert on the tip of the twelfth rib or above or below the rib; upon the existence of a tendinous arc in the aponeurosis of the transversalis muscle; furthermore, upon whether the median portion of the latissimus dorsi inserts in the eleventh or twelfth ribs or whether it unites with the posterior fibres of the external oblique, and finally the size and shape depend on the development of the quadratus lumborum.

The most common form is an acute angled quadrilateral, or a triangle. The thickness of the aponeurosis varies in this space but at the uppermost limit the thinnest portion of the lumbar region is seen. In this thin area vessels and nerves are found, usually the twelfth intercostal, and it is in this region that hernias most often occur.

Etiology.—In the etiology of the cases quoted in this paper, indirect traumatism alone is accepted as a cause, and all the cases are excluded in which the hernia followed direct injury, or was secondary to infectious processes, sinus formation, or visceral protrusions due to muscle paralysis. By indirect traumatism is meant conditions demanding habitual or sudden strain, lifting of heavy weights, coughing, and the strain following falls. In 14 of 33 cases, such a history is mentioned, the hernia appearing soon after the injury was sustained. Whether there has been a congenital predisposition in these cases is a matter of debate; there is little evidence to support such a view. It must be mentioned, however, that emaciation, old age, repeated pregnancies, by lowering muscle tone, predispose to the development of lumbar hernia. In those cases in which the age is given we find but 5 instances occurring before the fortieth year of life, 4 in each of the three succeeding decades, and in quite a large number of cases, the histories state that the hernia occurred in an elderly person.

There is a marked predisposition toward the development of hernia on the left side, 19 cases being noted here, 10 on the right side and 2 were bilateral. The hernias occurred 22 times in males and 9 times in females.

The hernia is generally subcutaneous but may be separated from the skin by a layer of fat or muscle. There is considerable doubt concerning the formation of a sac, for it has been distinctly noted at operation and at postmortem that a sac composed of peritoneum often is lacking. This

seems to be particularly the case in the hernias composed of fat protruding from the subperitoneal or perinephritic tissues.

The hernia is composed of fat, mesentery, large or small intestine or, in rare instances, the kidney, and as a rule the hernia is reducible without difficulty, even when symptoms of strangulation have developed. As to the site of the orifice it is impossible to determine this with accuracy in most cases unless an operation has been performed. Jeannel claims that hernias due to effort or to trophic changes in the muscles present themselves in Petit's triangle or in the Grynfeltt-Lesshaft space, while traumatic hernias and those due to disease may occur anywhere. In many cases the site of the hernia is distinctly stated, and where accurately described we have found that 6 cases occurred in the Grynfeltt-Lesshaft space and 9 in Petit's triangle. When all the cases are grouped together one triangle is involved about as frequently as the other.

The symptoms depend largely on the cause of the hernia. In our case the onset was insidious, the hernia entirely escaped the patient's notice until it was pointed out to him twenty years after the first symptom following strain. During these years he was convinced that the only inconvenience he experienced was a feeling of weariness in his back after a day of hard work. In this case as in a typical example of any type of hernia, the signs characteristic of a hernia were so well marked that there could be no question of the correct diagnosis. It should be mentioned, however, that errors in diagnosis have been made, and hernias have been incised in the belief that the condition was an abscess. In one instance the bowel was opened and a fecal fistula resulted.

Most authors speak of the serious nature of lumbar hernia because of the tendency toward strangulation. Jeannel in his analysis found strangulation in 18 per cent. of the cases; this collection including hernias due to all causes. In the 33 cases of spontaneous hernia we have collected, symptoms of intestinal obstruction or strangulation, either mild or severe, were mentioned 8 times, or 24 per cent. In many, the symptoms were mild and disappeared when the hernia was reduced. Reduction was accomplished easily, even when the symptoms indicated a severe form of strangulation, a feature probably due to the absence of a sac, removing the danger of constriction exerted at its neck.

Operative measures have been uniformly successful in the treatment of lumbar hernia, although the number of operations reported is comparatively small. Despite the fact that symptoms of strangulation are so frequently encountered, but one operative death is recorded. In



FIG. 1.—Lumbar hernia.

LUMBAR HERNIA

many instances comfort is secured by the use of a truss or belt and the hernia is thus retained within the abdominal cavity with a considerable degree of comfort. As so many of the patients are advanced in years, and in a debilitated condition, operation should be advocated with some degree of caution. Of course a radical cure should be undertaken when symptoms of strangulation arise, or when the general condition of the patient becomes a matter of concern from the pain and inconvenience of the hernia.

Patient, John C., aged fifty-eight, was admitted to the medical wards of the Presbyterian Hospital, service of Dr. James E. Talley, October, 1915, on account of nephritis. On examination of the patient, a swelling in the left lumbar region was noted. The patient said that until our discovery of this tumor he had been unaware of its existence. Just how long it had been present it is impossible to state, but the following history obtained from the patient leads us to suppose that it must have existed for many years.

The patient is a stone mason by occupation and is accustomed to very hard work. About eighteen or twenty years ago, while attempting to lift an unusually heavy piece of stone, he was seized with a sharp pain in the left side of his back, which persisted for about a week and which prevented him from working. He does not know if any swelling appeared at that time, and, as we have stated, has been unaware of any tumor existing in his side, until this autumn. This pain he was told was due to a strain, and since then he has often had attacks of "weak back," particularly when his work was unusually heavy. At times when he has attempted to lift a weight he has felt something tighten in his back, as if something were pinching him, but this sensation would pass off on assuming the upright position, and after resting a few minutes. He has never had any signs of strangulation, nor has there been any permanent interference with his work on account of his back.

Examination reveals the presence of a tumor in the left lumbar region just under the last rib. The tumor is about 3 cm. in diameter, is rounded and painless. On palpation the swelling is soft and may be easily reduced with gurgling, gives an impulse on coughing which makes the swelling more prominent as does any straining effort. On percussion the tumor is resonant and auscultation reveals peristaltic sounds. When the patient bends forward, the tumor becomes more prominent; when he lies on his abdomen, the tumor disappears spontaneously, and there may be felt a small opening in the dorsal muscles admitting the tip of the middle finger, against which is felt an impulse when the patient coughs. These

findings at once led to the certain diagnosis of lumbar hernia, presumably in the Grynfeltt-Lesshaft space, not in Petit's triangle.

We were interested in learning just what part of the intestine formed the hernia, and as far as we are able to decide by means of the X-ray, it is the small intestine which protrudes. Although recognizing that strangulation occurs in a larger proportion of cases than in inguinal hernia we advised against operation on account of the patient's age, the renal condition (nephritis) and on account of the benignity of the hernia, no symptoms developing during the eighteen or twenty years of its existence.

The accompanying photograph shows fairly well the site and the appearance of the hernia.

CONGENITAL LUMBAR HERNIA

Etiology.—The etiology of this form of hernia is unknown, unless it be due to congenital malformation.

For our knowledge of the anatomy we are dependent on the cases of Jeannel and of Coley, and it would seem that the sac is composed sometimes of parietal peritoneum itself, sometimes by the parietal peritoneum and large intestine, the descending colon when on the left side, the ascending colon when on the right. The sac is never adherent to the skin as far as is known.

The contents of the hernial sac may consist of any of the following—large bowel, small intestine, kidney. The site of the hernia may be either in the so-called triangle of Petit or in the space described by Grynfeltt, or in an anatomic region imperfectly described, along the external oblique at the level of the twelfth rib. As to the pathogenicity of this hernia, it may be said that the rupture falls in two categories, the one in which there has been a malformation, and the other not due to a malformation, but more in the nature of a paretic state of the muscles of the lumbar region.

From the diagnostic stand-point the recognition of a hernia should be easy, though there is a case on record in which the intestine was cut, under the impression that the swelling was an abscess (Dolbeau). It would seem that such a mistake should be impossible, as with a little care the diagnosis should be easily made.

Congenital lumbar hernia is an incurable infirmity. The course of the trouble is uncertain; there may be increasing discomfort or there may be progressive improvement with a support. There has been no record of strangulation having occurred, but one should always have before him the possibility of this accident.

Congenital lumbar hernia as well as the spontaneous type is never

LUMBAR HERNIA

cured by means of a bandage or truss, and it would seem that operative measures are to be urged.

CASES OF CONGENITAL LUMBAR HERNIA

CASE I.—Budgeon, 1728. Much contested and much discussed case. Tumor at birth, ruptured at seventeen years of age. Thought by some to have been lumbar hernia, by others, spina bifida, and by Jeannel to have been hydronephrosis.

CASE II.—Plenck, 1774. Hernia of kidney and not of bowel.

CASE III.—Monro, 1811. Hernia of kidney.

CASE IV.—Colles, 1829. Three years old. Tumor observed at time of birth. Tumor now size of a moderate-sized watch, at birth much smaller. Situated posteriorly immediately above skin of ilium, left side. Easily reducible.

CASE V.—Macready: "In 1882, a youth, aged sixteen, presented himself at the Truss Society, and has often been seen since then up to the present time (1890). Soon after birth a swelling was observed on the right side, for which a belt was worn during six months. The lump then disappeared, but was again noticed when he began his apprenticeship as a plate worker, some months before his appearance at the Society. He then had a hernia of the size of half an orange; it was easily reducible, and escaped by an opening immediately below and anterior to the tip of the twelfth rib."

CASE VI.—Mastin, 1890. Male. When six years of age, hernia measured eight and a half by nine inches, contents of sac were small bowel and descending colon. Apparent defect of latissimus dorsi and quadratus.

CASE VII.—Wyss, 1892. Boy, nine months old. Many other congenital defects. Right sided hernia through Grynfeltt's triangle.

CASES VIII and IX.—Berger, 1895. Simply says he has seen two cases, one in a sclerotic, the other in a little child, probably due to congenital defect of the muscles in the lumbar region.

CASE X.—Coley, 1895. Eleven months old child, with a hernia protrusion about the size of a goose egg in the left lumbar region. Noticed since birth and was probably due to a congenital malformation of the abdominal parietes, allowing this mass to protrude through the triangular space between the latissimus dorsi.

CASE XI.—Russell, 1898. Child. Doubt whether congenital or due to congenital absence of a portion of abdominal wall. Hernia is visible except when muscles were stretched. Was inclined to treat by transplant of muscle.

CASE XII.—Jeannel, 1902. Boy, four months old. Shortly after birth, tumor in right flank, size of hen's egg, situated between last rib and iliac crest. Tympanitic on percussion, reducible, increased by exertion, decreased by rest. Operation. Cure.

ABSTRACT OF CASES OF SPONTANEOUS LUMBAR HERNIA

1. RAVATON: Female, age not given, tumor of three weeks' duration, situated in the left lumbar region. Symptoms of strangulation developed. Operation. Cure.

2. PETIT: Patient was an adult female, hernia on left side in Petit's triangle, size of a child's head. Strangulation relieved by taxis. Recovery.

3. MONRO: Bilateral hernia in a child six months old, covered by skin only, immediately under the false rib. Each tumor contained kidney, easily reduced through an oval ring of a considerable size.

4. CLOQUET: Male, aged seventy-five, pain in lumbar region following strain; pain disappeared; recurred in two months with an attack of nausea and vomiting. Round tumor found in right lumbar region, 1 cm. from last rib. Tumor painful on palpation, gurgling, impulse on coughing. Symptoms relieved after reduction. Application of a truss gave considerable relief.

5. KINGDON: Male, aged fifty-four, for several years had asthma and cough. Eight days before he tried to lift a fire engine which he was cleaning and felt something give way in his back. At night when he undressed a swelling was felt which grew larger as he coughed. The hernia was the size of a fist and was situated between the lower ribs and the iliac crest on the left side. It was reducible, and the hole through which it came was small and above the iliac crest, about three inches from the spine at Petit's triangle. It felt crepitant, not gurgling, on reduction. The integuments over it were thin. On exhibiting the patient it was generally and unhesitatingly admitted that the swelling was a hernia through the foramen of Petit. (Quoted by Macready.)

6. BASSET: Young man with a swelling in the left lumbar region, size of an apple and ovoid in shape; had had this tumor since childhood. It was soft, elastic without fluctuation and resembled a lipoma. Coughing increased the size, gave impulse, expansible in character, reducible. There was a family predisposition to hernia in this case.

7. HARDY: Woman, thirty years old, admitted to the hospital for syphilitic paraplegia. While straining at stool noticed a tumor eight centimetres in diameter, just above the iliac bone, subcutaneous, large base, hemispherical, about the size of a fist, soft, no change in color of skin, no fluctuation, resonant on percussion. Reducible with gurgling, reappears on coughing and on effort, impulse. Patient perfectly well.

8. MARQUEZ: Old woman; while attempting to lift a heavy load of grass, felt a sudden pain in the side, becoming more and more painful and being accompanied by nausea, colic and extreme anxiety. Swelling in left flank, tender, gurgling, and spontaneously reduced. This hernia had been present five or six years.

9. TRIPONEL: In the discussion of Marquez's paper, Triponel said he was reminded of a strangulated right-sided lumbar hernia; operation. A year later another strangulation and a new reduction. Patient advised to wear a truss and to avoid violent muscular effort.

10. LEVY: Old country woman, swelling in left flank at side of Petit's triangle. Never had any serious inconvenience. Patient thought the tumor gave her lumbago on that side.

11. TURENNE: Case of elderly male with tumor in left flank of three years' standing, and arising without any apparent cause. It was the size of a nut, uneven, and rounded, and seemed to consist of a portion of the omentum. It was reduced easily, was kept in place by means of a bandage. It had never caused any inconvenience.

12. DOLBEAU: Old woman, no mention of the side. Opened for abscess. Recovery.

13. APPERSON: Female, aged sixty-three, tumor on right side, size of a tea-cup, now and then presented signs of strangulation but was easily reduced and retained by bandage and compress. Woman feeble and relaxed as the result of child-bearing.

14. COLE: Male, no ascribable cause. Hernia right side, toward the top of

LUMBAR HERNIA

Petit's triangle, size of a hen's egg; soft, reducible. Few months later patient, a soldier, being no longer able to keep up his occupation, was brought to hospital. At this time a large hemispherical tumor 12 to 14 cm. in diameter was noted, soft, no skin changes, readily reducible with gurgling, contents probably ascending colon.

15. COZE: Soldier, right side, toward top of Petit's triangle, 6 by 4 cm. in extent; reducible small tumor; gurgling. Previously operated on for this swelling, scar of operation on skin. The following month tumor had enlarged, was reducible, impulse, no gurgling.

16. GOSSELIN: Male, aged fifty-five. When fifteen years old had lateral curvature of spine, to the right. Since five or six months some pain in left renal region, colicky in character. When he coughs or exerts himself, side pains him, obliged to stop and press it with his hand. In the left lumbar region a hernia, the size of a mandarin; reducible.

17. MACREADY: A man aged fifty-four came to the Truss Society in 1884 with a swelling over the left triangle of Petit, about the size of a walnut. It increased somewhat on coughing, but was not reducible, and therefore, as this aperture could not be examined, some doubt exists whether the tumor was a hernia or a lipoma. He had also a left inguinal hernia.

18. MACREADY: A man aged thirty came to the Truss Society in 1889, who stated that usually after a hard day's work he had pain in the right side in the position of Petit's triangle. An impulse and a bulge on cough were found there, but no complete protrusion.

19. HUTCHINSON described an autopsy on an elderly emaciated man with a hernia the size of a fist, in the left lumbar region, extending from the last rib to crest of ilium; several years in duration; diminished on pressure, resonant on percussion, impulse on coughing, gurgling; no pain, no inconvenience. Thought it was in Petit's triangle, but on dissection found an opening above and to the inner side of Petit's triangle, was outside of the quadratus lumborum, through the transversalis and the latissimus dorsi. No sac of peritoneum found, but one formed from local hypertrophy of subperitoneal fat.

20. HUME: Male, aged sixty-eight, tumor in the left lumbar region for fifteen years, size of a fist, but became larger at intervals, when it was painful and symptoms of intestinal obstruction developed. When admitted for treatment, symptoms of strangulation had been present for two days, operation disclosed gangrenous small intestine caused by pressure of two fibrous bands, and a twisted sigmoid. Hernia did not seem to be in Petit's triangle. Death in twenty-four hours.

21. RUPPNER: Male, aged forty-eight, history of strain and fall followed by pain in left lumbar region. Operation eleven days after injury disclosed a rent in lumbocostal fascia, 1 cm. in length, through which protruded a nodule of fat, size of a cherry. No sac present, tumor reduced, rent and muscles sutured. Hernia was in trigonum lumbale superior.

22. STARR: Male, age not given; eighteen years ago fell while carrying a sack of grain on shoulder, and hurt his side. He thinks lump did not appear at that time. Twelve months ago while stooping down preparing to lift a weight he was seized with pain in the side, which for a few minutes prevented him from assuming the erect position. After the severe pain had ceased, he noticed a lump in his back which has persisted ever since, always a steady pain in the side,

which sometimes becomes sharp and shoots into the backbone. The swelling is about the size of a duck's egg, its long axis being directed from above, downward and outward, and is situated in the right lumbar region, between the lower border of the ribs and the crest of the ilium. Slightly tender on pressure, elastic, reducible; crackling sensation on reduction, on straining tumor gives tympanitic note.

23. GALLOWAY: Male, after being in the army for four years, developed hernia which was the size of a partridge's egg, and has gradually grown to present dimensions, five inches in length by two inches in width, left side.

24. DUMESNIL AND BRUMON: Male, sixty-one years old, complained of shortness of breath and sometimes dyspnoea. During the examination, patient strained and immediately there appeared a tumor in left lumbar region. He says he noticed this fourteen years before. At this time it was about the size of a walnut and painless. In 1891, it was the size of a mandarin orange, but had not increased in size since then. When the patient rested, no tumor, but on exertion it became quite large. It is painless, gurgling and reducible. Never prevented patient from pursuing his occupation as collier. Since 1885 a bandage has sufficed to hold the tumor in position.

25. ZENTNER: Female, aged six years; following whooping cough, developed a walnut-sized tumor in the left lumbar region, also history of violent strain in falling, followed by pain the same day and tumor a few days later. Bandage applied but tumor enlarged in spite of constant pressure. Now tumor is size of hen's egg, is soft, tympanitic and is reduced easily, no gurgle. Situated in Lesshaft's triangle. Operation disclosed sac of peritoneum projecting through transversalis, omentum in sac, sac and muscle sutured. Cured.

26. DEMOULIN: Male, forty-seven years old, mason, who, as a result of a violent effort six months before, felt a severe pain in the lumbar region, followed by an egg-sized tumor. No serious accident has resulted from tumor. Diagnosed lipoma, not completely reducible. This was a hernia developing from the fat capsule of the kidney.

27. JONES: Male, aged forty-five; tumor present for four or five years, lately producing local pain and tenderness, constipation and dyspnoea. Hernia on right side, extended from the ribs to iliac crest; reducible with gurgle; impulse on coughing. Operation. Fat found in hernia; no sac, cure.

28. BARACZ: Male, aged thirteen. Tumor left-sided, below twelfth rib, size of a billiard ball, also small one in left flank. Straining causes prominence, tympany over hernia, reducible, in Grynfeltt's triangle.

29. GAILLAC: Soldier jumped from height; immediately felt severe pain in the lumbar region and swelling—egg-sized tumor, soft, painful, reducible.

30. LEJARS: A man sixty-five years old developed symptoms of strangulation in left lumbar region; large tumor, painful, reducible. Patient stated that he had had it twenty-five years and during this time it was the size of a walnut. In the first three weeks it had been growing in size, painful and colicky. During the last six days obstinate constipation; for past three days not even gas came from the rectum; extreme nausea, distention of abdomen, and pain, particularly in the left flank. Tumor is spherical, little flattened, 7 cm. in diameter, about 3 cm. long, extending to iliac crest, skin reddened. Operation; no peritoneal sac but large intestine found. Recovery. Believes it came out through Petit's triangle.

31. FRIEDENTHAL: Female, aged forty-five. Injury to the spine by fall, and six years later strangulation in lumbar region appeared. Patient could not give any

LUMBAR HERNIA

history of hernia. Cherry-sized hernia in left side, under twelfth rib, attributed to weakening of the muscles following frequent pregnancies and the indirect traumatism of the fall.

32. SECOUSSE AND LASSERE: Male, age not given, carried heavy weight upstairs, three days later noticed a small tumor in left lumbar region about the size of a nut. Ten days later it was the size of a pigeon's egg. This was three years ago and now it has increased very much in size. Round, about the size of two closed fists, becomes larger when patient coughs, and spreads widely over the lumbar region. Reducible and gurgling, non-painful.

33. GOODMAN AND SPEESE: See above.

BIBLIOGRAPHY

SPONTANEOUS LUMBAR HERNIA

Apperson: Quoted by Mastin, *ANNALS OF SURGERY*, 1890, xii, 20.

Baraez: *Arch. f. klin. Chir.*, 1902, lxxviii, 650.

Basset: *Bull. de la Soc. de Méd. de Toulouse*, 1864.

Cloquet: *Recherches sur les causes et l'Anatomie des hernies abdominales*, 1819, p. 4.

Coze: *Rev. méd. de l'Est.*, 1874, p. 407.

Demoulin: *Congrès des Sociétés Savantes*, 1901.

Delbeau: Quoted by Larrey, *Bull. de l'Acad. de Méd.*, 1869, xxxiv, 135.

Dumesnil and Brunon: *Bull. méd.*, 1889, xiii, 781.

Friedenthal: *Berl. kl. Woch.*, 1911, lxxviii, 407.

Gaillae: Verbal Communication to Jeannel.

Galloway: *Medical Record*, 1895, xlvii, 294.

Gosselin: *Gaz. méd. de Paris*, 1881, p. 123.

Hardy: *Bull. de l'Acad. de Méd.*, 1869, xxxiv, 124.

Hume: *Brit. Med. Journal*, 1889, ii, 73.

Hutchinson: *Ibid.*, p. 71.

Jones: *Lancet*, 1902, ii, 747.

Kingdon: Quoted by Maeready.

Lejars: *Congrès franç. de Chir.*, 1905.

Levy: Quoted by Marquez.

Maeready: *Lancet*, 1890, ii, 963.

Marquez: *Gaz. méd. de Strassbourg*, 1869, p. 274.

Monro: *Observations on Crural Hernia*, 1903, p. 8.

Petit: *Traité des Maladies Chir.*, 1790, ii, 225.

Ravaton: Quoted by Jeannel. *Traité des pratiques modernes de la Chir.*, 1776.

Ruppaner: *Deutsche Zeitschrift für Chir.*, 1908, xevi, 461.

Secousse and Lassere: *Journal de méd. de Bordeaux*, 1913, xliii, 594.

Starr: *Canadian Practitioner*, 1894, xix, 491.

Triponel: *Gaz. méd. de Strassbourg*, 1869, p. 275.

Turenne: Quoted by Larrey, *Bull. de l'Acad. de Méd.*, 1869, xxxiv, 135.

Zentner: *Wiener klin. Woch.*, 1901, xiv, 1232.

CONGENITAL LUMBAR HERNIA

Berger: *Congrès française de Chir.*, 1895, p. 328.

Budgeon: *Philosophical Transactions*, 1728.

Coley: *ANNALS OF SURGERY*, 1895, xxii, 272.

- Colles: *Dublin Quarterly Journal*, 1857, xxii, 380 (date of observation in 1829).
 Jeannel: *Archiv. provinciales de Chir.*, 1902, xi, 1903, xii.
 Macready: *Lancet*, 1890, ii, p. 963.
 Mastin: *ANNALS OF SURGERY*, 1890, xii, 20.
 Monro: *Morbid Anatomy of the Human Gullet, Stomach and Intestines*, 1811, 374.
 Plenck: Quoted by Jeannel.
 Russell: *Intercolonial Medical Journal*, 1898, iii, 113.
 Wyss: *Beiträge z. klin. Chir.*, 1892, p. 1.

TRAUMATIC HERNIA AND CONTRIBUTIONS TO THE SUBJECT OF LUMBAR HERNIA

- Bayer: *Centralblatt f. Chir.*, 1888, xv, 686.
 Bestendank: I. D. Marburg, 1889.
 Billeton: *Thèse de Paris*, 1869, No. 103.
 Bonisson: *Beiträge z. klin. Chir.*, 1907, liv, p. 229.
 Blanel: *Montpel. Med.*, 1866, xvi, 330.
 Braun: *Arch. klin. Chir.*, 1879, xxiv, 213.
 Broca: *Gaz. Hebd. de Méd.*, 1891, xxviii, 428.
 Calvert: *Indian Med. Mag.*, 1901, xxxvi, 19.
 Campbell: *N. Y. Med. Jr.*, 1874, xix, 184.
 Casteny and Philippe: *Echo. Med.*, 1901, xxv, 15, 313.
 Chaplain: *Gaz. des Hôp.*, 1861, p. 406.
 Currier: *Lancet-Clinic*, 1880, n.s., iv, 98.
 Decaisne: *Ann. de la Soc. de Méd.*, 1838, iv, 483.
 Dolbeau: Quoted by Larrey.
 Duplay: Quoted by Rigodin, *Thèse de Paris*, 1872, p. 12.
 Duret: *Echo. Med.*, 1891, v, 325.
 Garangeot: Quoted by Jeannel, *Traité des Operations*, 1731, p. 369.
 Grange: *Thèse de Lyon*, 1896.
 Grynfeldt: *Montpel. Medicine*, 1866, xvi, 329.
 Hein: I. D., Berlin, 1902.
 Hein: *Cent. f. Chir.*, 1902, xxix, 201.
 Larrey: *Bull. de l'Acad. Méd.*, 1869, xxxiv, 135.
 Lesshaft: *Arch. f. Anat., Physiologie, Med.*, 1870, p. 264.
 Lieber: *Über Lumbalhernie*, I. D. Berlin, 1887.
 Macready: *Lancet*, 1890, 963.
 Makrocki: I. D., Strassburg, 1879.
 Marmisse: *Gaz. des Hôp.*, 1862, p. 170.
 Nélaton: Quoted by Larrey.
 Owen: *Brit. M. J.*, 1888, i, 957.
 De Quervain: *Dent. Zeit. Chir.*, 1902, lxxv, 156.
 Raymond and Maisonneuve: *Limousin Med.*, 1897.
 Schenk: *Prager Med. Woch.*, 1900.
 Schraube: Quoted by Braun.
 Sistach: *Rec. de mem. de Med. chir., Eng.*
 Sweet: *Austral. Med. Gaz.*, 1912, xxxii, 351.
 Tereschenkow and Federow: *Russ. Arch. f. chir.*, 1903.
 Tucker: *Am. Jour. Obstet.*, 1893, xxviii, 380.
 Van Hulst: Quoted by Mastin, *ANNALS OF SURGERY*, 1890, xii, 20.
 Verdier: *Traité nat. des Hernies*, 1840.
 Wolff: *Berliner klin. Woch.*, 1890, xxvii, 3; also *Arch. Klin. Chir.*, 1880, xxv, 908.

ON PERFORATING AND VARICOSE ULCERS OF THE LEG AND THEIR TREATMENT BY NERVE OPERATIONS

By J. C. J. C. SMITS, M.D.

OF SUMATRA

DIRECTOR OF THE CENTRAL HOSPITAL OF THE BENNAH RUBBER COMPANY, LTD., AT BILA (EAST COAST OF SUMATRA)

THE value of nerve-stretching in the surgical treatment of trophic disturbances is brought into prominence by the results of operations in the two categories of affections, for which A. Chipault has first recommended them, founded on a scientific method; namely, in the *malum perforans pedis* and the *ulcera varicosa*.

Until now, the sphere of trophic disturbances has been under the influence of hypotheses. Passing over in silence the theory of Marinesco concerning their nature being too complicated to allow the formulation of a working rule, efficient in practice, we may lay stress upon the clinical facts, which show the trophic disturbances to be the result of alterations in special vasomotor nerve-fibres most in keeping with surgical experience. According to this opinion, nerve-stretching as a therapeutical measure against trophic disturbances is to be considered as a method of the surgery of the sympathetic system. This conception is confirmed by some observations in which trophic disorders have been treated with success by operations on the sympathetic. In that manner Chipault treated with good results an obstinate gunshot wound of the face, by bruising the cervical sympathetic nerve. Jaboulay treated trophic disorders of the foot, which were of a gangrenous nature, by exposing the *arteria femoralis* and loosening the vasomotor nerves which surround this blood-vessel.

Nerve-stretching is a less drastic operation than splitting up the nerve into its constituent fibres, and than more direct interference on the sympathetic nerve system. In the latter, localization is more difficult, the operation is more dangerous; and the results have yet to be ascertained, whereas they have already been shown to be successful in the cases of nerve-stretching and laceration.

Tests on animals are not necessary to give evidence of the use of Chipault's operation. Perhaps later on they may be necessary to prove the nature of diseases in whose treatment the operations have been shown to be efficient, and the manner in which they produced their beneficial effects; or to furnish proofs of hypotheses of the relations between these operations and the diseases which are thus treated.

We may accept the practical use to be demonstrated, and therefore we must wonder, for instance, at the ulcer cruris being chosen by the dermatologists for their experiments with ointments and powders, where only an intensive surgical treatment can be of lasting use and can prevent relapses. When drawing attention to the trophic influences shown by nerve-stretching in those cases in which this operation was undertaken with another purpose, such as the treatment of neuralgia, the lightning pains of tabes, it is striking how large, in regard to these influences, is an amount of information which has been laid down in literature since 1875. This information gives evidence of the fact, that the trophic symptoms which accompanied the affections for which the operation was performed, either were cured by the influence of nerve-stretching or showed a change for the better. Therefore, properly speaking, it is not necessary to experiment on animals to ascertain the basis of the treatment of trophic disturbances by nerve-stretching.

Besides this, the special causation of trophic disorders in animals gives rise to a special pathology, which does not allow of conclusions regarding the human body, without considerable restrictions.

To conclude, as the treatment of trophic disorders by nerve-stretching was not founded on empirical knowledge, but on well stated clinical experience, trophical disturbances, whether of central or of peripheral origin, may advantageously be treated by this operation.

I. MALUM PERFORANS PEDIS

This ulcer ought to be considered as, more than anything, the prototype of a localized trophic disorder, and, in the treatment of this affection, Chipault first applied nerve-stretching following the preliminary observations of Duplay and Morat, on the nervous origin of perforating sores of the foot. Nélaton first described the affection in 1852 as a separate disease, *mal affection singulière des os du pied*, and Vésigné has given it the name of *mal perforans plantaire sine du pied*. German writers, not satisfied with this name, have rebaptized the affection as neuroparalytic sores. But trophic disturbances do not only appear when a nerve bundle is destroyed, but also when it is in a state of permanent irritation, so that the name *malum perforans pedis* typifies the affection much better. Let us then in honor of Nélaton and Vésigné preserve this name.

The *malum perforans* is not a real etiologically limited disease. There may be several causes of this affection. These sores are known to be characterized by their painless course, a preference for penetrating deeply, and obstinately opposing every treatment, whilst they have a

strong tendency to relapse. Their anæsthesia and analgesia are most characteristic and are not confined to the sore and its near environment, but may also be found in other circumscribed spots of the feet, or on the whole foot. To the due diagnosis of a *malum perforans*, these nerve-disorders, accompanying the sore, are of the utmost importance.

The sores, as a rule, are situated on the sole of the foot, under the metatarsophalangeal joints, the large and little toe, and the heel; but besides this, they may occasionally be seen in any part of the foot, on the hand, or even in the mouth.

Very often no primary cause can be found, and yet a rank growth of epithelium, with horny induration of the skin, is formed. Under this *clavus* a suppuration may occur by accidental infection of a *bursa mucosa*, or other incidental affection. Pus being discharged, a little sore appears, with steep, undermined borders, formed by the horny induration and thickening of the epithelium. The sore does not tend to heal and, though it may seem to be cured, it soon breaks open again, extending down into the deeper layers. Depending on the place of development, tendon-sheaths and joints may be opened, bones may be deprived of their periosteum and become eroded. A transient cure may rarely be obtained. Usually, the sore is neglected by the patient, while it is painless; but gradually it secretes a viscid, bad-smelling matter. These *mala perforantia* do not rarely, while penetrating, lead to suppuration of the joints, necrosis of the bones or serious gangrene. The sore develops so slowly, that its course may extend over several years.

The neuropathic joint and bone affections were especially esteemed by Levy (*Die Entstehung des Mal Perforant du Pied: Mittheilungen aus den Grenzgebieten der Medizin und Chirurgie*, 1909. *Bruns' Beiträge zur klinischen Chirurgie*, 1909, p. 627, Bd. 70) to be of such importance, that he emitted the thesis: A *malum perforans* is only caused by diseases of the bones and joints. He founded his opinion on 12 cases of *malum perforans*, in which he demonstrated, having taken radiographs, that in all these cases the *mala perforantia* coincide with arthropathies.

At a meeting of the Danish Surgical Society (*Centralblatt für Chirurgie*, 1913) Köster read notes of a case of *maux perforants* of the region of the metatarsophalangeal joints of the soles of both feet. The patient, a diabetic of fifty years of age, had suffered from perforating ulcer for nine years, without symptoms of disease of the central nervous system. A radiograph showed atrophy and fractures of the metatarsal bones.

Brutzer (*Deutsche Zeitschrift für Chirurgie*, 1913) communicated a case of *lepra* in which the patient showed *maux perforants* of both

feet, under the first metatarsophalangeal joints. These joints *were intact*, until in one foot this joint was opened. After resection of the affected joints, patient was cured notwithstanding the atrophy of the soft tissues, because pressure by walking was divided over a great surface. For this reason the cure was lasting and the function of the foot was saved. On this ground Brutzer discredits the theory of Levy, the existence of joint and bone affections not being necessary. In his opinion a *malum perforans* proceeds from pressure, exerted while walking, in neuropathic persons, by generally deformed bones of the foot, on the atrophic soft tissues and the skin, situated under it.

As said above, one remarks, besides the sore, several disorders of the nerves. On careful examination, as already mentioned, anæsthesia as well as analgesia, whether of the whole foot, or in the neighborhood of the sores, may be noted, often accompanied by trophoneurotic disturbances of the nails, skin, bones or joints. Moreover, pareses and disorders of the reflexes may be observed. However, all these signs are not to be considered as diagnostic marks of a *malum perforans*, but as symptoms of the original disease, which are not essential to the diagnosis of perforating sores of the legs. In keeping with this variety of accompanying nervous disorders, the nature of the primary diseases of the nerves shows an equal manifoldness. Tabes, syringomyelia, wounds and diseases of vertebræ accompanied by secondary diseases of the spinal cord, spina bifida, neuritis in its different forms, wounds and growths of peripheral nerves—all these and many others have their place in considering the etiology of perforating ulcer of the foot.

Malum perforans is met with in the early stages of tabes and is situated, as a rule, on the sole of the foot in the region of the metatarsophalangeal joints, frequently under the large toe. It may also appear on other parts of the sole, at the heel or above it, as a little circular sore, gradually increasing in depth, up to, or even including, the bone. The sore is very chronic and almost painless, its cure is tedious. Secondary affections of the joints of the toes and necroses of the bones are by no means rarely seen as sequels of *mala perforantia*.

Contrary to the opinions in former times, which generally accepted sensory and trophic disorders of the feet as rarer than those of the hands, of late years many publications have been made, giving evidence of cases of *malum perforans* in syringomyelia, localized, just as in tabes and peripheral neuritis, on the soles of the patient, as seen in a typical case which I treated.

As to the combination with rarer diseases of the central nervous system, it may be mentioned, that I am treating in hospital a case of

PERFORATING AND VARICOSE ULCERS OF THE LEG

malum perforans in a patient suffering from spastic spinal paralysis, a disease extremely rare in a Japanese, and a combination yet rarer in pathology.

We cannot wonder that Eichhorst and Schwarz, having observed the malum perforans pedis (as the cause of death) in a case of myositis ossificans progressiva, considered this disease a trophoneurosis (Nicoladoni) or an after effect of diseases of the spinal cord (Eichhorst).

But properly speaking, the malum perforans belongs to the phenomena of disease most common in the course of a neuritis, although when looked at in the proper light, it cannot be considered as a sign of value in the differential diagnosis of neuritis from tabes. In the several forms of neuritis malum perforans is most common in cases of alcoholic neuritis and diabetes, but is also occasionally seen in leprosy. Several neurologists, as Cassirer (Neuritis and Polyneuritis, *Deutsche Klinik*, VI, p. 1007), express their opinion very cautiously as to the etiological relations between alcoholism and malum perforans. It seems, Cassirer says, to occur in relation to a chronic alcoholic intoxication. Adrian prefers in his essay (*Das Mal perforant du Pied*, 1904) not to explain such cases as of neuritic origin, but as due to an altered hæmatopoiesis.

Jeannel and Kirmisson first drew attention to the neuritis, often occurring in the course of diabetes and giving rise to a malum perforans. But Cassirer (*loc. cit.*, p. 1051) also expresses his opinion on their connection with a diabetic neuritis with some reserve and says: in the explanation of the genesis of a trophic disturbance, it is necessary to take into consideration, besides the alteration of the nerve, another circumstance, and this is a mechanical action by pressure—at all events on tissues already injured in their capacity for resistance, by nervous or other influences. Perforating ulcer of the foot has no clinical significance in neuritis, as it is only exceptionally an accompaniment of sciatica and even more rarely of polyneuritis. But these sayings of the neurologist are by no means established by surgical experience. After all, we have in surgical literature hundreds of well described and exactly observed cases of mala perforantia, occurring in alcoholism and diabetes. Now it is quite possible to construct many hypotheses in explanation of these facts, but it is impossible to reason away the plain truth, mentioned above; and when we see nerve-stretching to be of preponderating therapeutic effect in the treatment of this affection, we must indeed accept the conclusion, that nerve diseases, whether localized in the whole

bundle of the sciatic nerve or in its vasomotor fibres only, have a connection with these disorders.

The surgical facts, observed with irrefutable certainty, cannot be explained by an altered hæmatopoiesis, as accepted by Adrian and Cassirer, but very well by disorders in the nerve. So we are strictly within our rights, when sustaining the thesis: that the neuritis occurring in diabetes and alcoholism very often gives rise to a *malum perforans pedis*, as may be seen from the tabular statement of my cases at the end of this paper. Especially in diabetes, perforating sores of the foot are very frequent.

As to the *malum perforans* in leprosy, formerly it was called a leprous sore. Wrongly, indeed; then it is not caused by the *bacillus lepræ* as such, but by the nerve disorders occurring in cases of *lepra anæsthetica*. Deycke believes these affections of the soles of the feet to be a peripheral disturbance. The trophic ulcers of leprosy, which are entirely comparable to trophic ulcers of other origin, especially in their chronicity, do not prove anything against the peripheral-neuritic conception of nerve-leprosy. Consequently this eminent expert in leprosy considers, according to surgical clinical experience, that *malum perforans pedis* in leprosy is caused by a peripheral neuritis.

Many points in question concerning the perforating sore of the foot are yet unexplained, although they have their significance in the treatment. I have observed in my hospital many cases of *malum perforans* of the heel and of the toes, but especially of the toes, to which the current etiological considerations were not appropriate. The number of those suffering from beriberi, which sickness was the cause of nervous disorders in the legs with ataxic signs, must not be neglected, and proved beriberi to be one of the etiological possibilities of *malum perforans*.

Typhus has not yet been recorded as an etiological factor; but I have notes of two cases in my practice in Europe.

Besides neuritis, peripheral lesions of nerves may give origin to *malum perforans*. Bennecke observed a case of trophic *malum perforans* after a peripheral gunshot wound of the sciatic nerve with a slight paresis of the leg and analgesia of the lower parts, especially of the foot. Chipault described a similar observation, and I treated an identical case.

With regard to former ideas of *malum perforans*, a consideration of Tillaux's communications makes it clear that he attached too much value to the symptoms without tracing their origins. Tillaux believed the real origin of *malum perforans* to be mechanical. It develops under the influence of repeated pressure in persons who walk much and whose

PERFORATING AND VARICOSE ULCERS OF THE LEG

feet have an irregular form, whether congenital or acquired by the weakening of some muscles or groups of muscles.

This may be true, but usually a malposition of the foot, or a limp, will prove to be caused by disturbances of the nerves—usually neuritis. Or the disorders of gait have mechanical causes, deformities of the bones or joints and, accordingly, we might fancy the nerve disorders to be the effects of chronic pressure, by abnormalities of the gait, on small nerve roots, giving origin to a neuritis, which remains at first circumscribed, but tends to spread. Then the source of trophic disorders is obviously on the spot where pressure gave origin to a *mal perforant plantaire*.

On the foot and chiefly in the sole, many other causes of sores are met with; such sores also are very obstinate and penetrating. They are clinically very different from *malum perforans* and, by attending especially to analgesia and anæsthesia, they will not easily give rise to error.

In the tropics perforating tropical sores may be found in the sole of the foot. They have, however, their own characteristics, consisting in a peculiar clinical course with microscopical evidence of the symbiosis of Le Dantec-Vincent. This affection I have described *in extenso* with evidence founded on the records of 241 cases, exactly observed and microscopically examined (*Geneeskundig Tijdschrift voor Ned-Indië*, 1914, p. 674). These sores always avoid the horny indurated sole, the favorite site for perforating ulcer.

Moreover, we may at first have some difficulty in distinguishing *malum perforans* from syphilitic sores and carcinomata of the sole, but we have to remember the characteristic course of syphilis and its serum reaction, the test of Wassermann and of Noguchi. As to the diagnosis of carcinomatous ulcers we must not lose sight of the macroscopical and microscopical properties of these growths.

Gangrenous inflammations and sores of the sole caused by an atheromatous degeneration of the vessels, and finally suppurations under callosities of the foot may be met with, originating from little bursæ mucosæ, which are the cause of fistulous ulcers of these cavities and of undermined sores. When neglected, they can perforate joints and sheaths of tendons just like a *malum perforans* and may even cause necrosis of the bones.

This series of affections of the sole ought obviously to be excluded from treatment by nerve-stretching; this treatment only being efficient in the disorders conveniently grouped under the name of *malum perforans pedis*.

The German proposal to rebaptize this affection as *ulcus paralyticum* is of no practical use, as I already mentioned above, and, besides this, it is yet more adapted to cause confusion and hazy ideas. We must give the French the credit for being the first to show exact knowledge of these affections and for being the first not only to describe them correctly but also to institute an efficient treatment. Is it not a well-known fact that, with all the therapeutical measures undertaken against perforating sores of the leg before 1895, the treatment was generally of no lasting use? A. Chipault was the first who began with nerve-stretching and, although with some modifications, his method has proved to be, till now, the only efficient one in the treatment of *mal perforant*.

The plan of cure consists of two stages. The first stage concerns the disinfection of the sore, the second stage the operation proper, which is divided into two stages, the first of which consists in the nerve-stretching, the second in the direct surgical treatment of the sore. As to the first stage depending on the state of the sore and its extent, it will be a radical treatment or it will not. Usually it is necessary to scrape the sore with a sharp spoon, to remove necrotic fragments of bones, to lay open freely and to scrape out thoroughly the fistulous ulcers. This is followed by a radical treatment with tincture of iodine.

In those cases in which the *malum perforans* is characterized by acute inflammation and is complicated with a lymphangitis, it is necessary to remove collections of pus, when such are present, and to be satisfied for the moment with a radical cleaning up.

When the sores are cleaned in this way or the floor of the ulcer was already clean, they are treated with a solution of boric acid or of hydrogen peroxide. Strong chemicals must be avoided.

Only after a relatively sufficient disinfection of the sore may we pass to the second stage. This stage consists, first, in the nerve-stretching; second, in the direct treatment of the *malum perforans*.

This operative treatment requires a general narcosis, as spinal cocainization or injections of cocaine or such like solutions round the nerve-trunks are contraindicated, as having a bad influence on the nerve-trunks and their branches. It is a well-known fact that injections of the above-mentioned solutions may produce sores of the legs in *cobaya*. Also Schleich's method of infiltration anæsthesia is out of place here.

As to the nerve-stretching proper, we have, in performing this operation, to pay attention to the following principles. The stretching must reach the nerve-trunk in whose trophic area the sore is situated, but must not be done too near the sore; because, as a rule, *malum per-*

forans is but one of the components of a trophic complex, extending over a more considerable surface than that of a little nerve-branch. Besides this, it may be a matter of indifference to operate in a region of trophic œdema, but it is not at all so to operate in the proximity of a chronic, nearly always infected ulcer. But we must also take care not to operate too far away from the sore, because the effect of the operation, *when only consisting in nerve-stretching*, might thus be insufficient or might even be nullified. When we have indications that it is advisable to operate at a greater distance, stretching has not a sufficient effect and lacerating the nerve-trunks is of much more use. Relapses are apt to occur if this rule be neglected.

In relation to nerve-stretching as a treatment of mala perforantia, we may mention the following nerves, as being of great importance: (a) The external and internal plantar nerves at their origin; (b) rami digitales of the musculocutaneous nerve; (c) external saphenous nerve.

(a) *Exposure of the External and Internal Plantar Nerves at Their Origin*.—In the hollow of the heel a finger-breadth below the lowest point of the malleolus, the posterior tibial nerve divides into its two branches—the internal and the external plantar nerves.

To discover these two nerves at the origin, a semilunar incision of the skin is made on a line going down from the point of the internal malleolus, with the concavity above, toward the inner border of the foot, up to the most anterior projection of the axis of this malleolus.

The superficial fascia is divided after having been stretched by external rotation and abduction of the foot, then the director is introduced from top to bottom in the groove containing the vessels and nerves.

Exploring with the finger, it is necessary to feel sure that only the superficial tissue is raised and then the incision on the groove of the director may be made. The vessels are situated, as a rule, above the nerves, only exceptionally beneath.

Now the foot is brought back to the normal position and the vessels, freed by this movement, can be cautiously raised upward and forward, and the nerves easily isolated and treated, whether together or separately.

(b) *Exposure of the Musculocutaneous Nerve of the Leg (Origin—External Popliteal Nerve)*.—The musculocutaneous nerve forms the posterior branch of the external popliteal, first crossing the peroneus longus, then coursing between this muscle and the extensor communis digitorum, to which it gives motor branches, and finally between the peroneus brevis and the extensor communis digitorum; it penetrates the

fascia to take a subcutaneous course, where it divides into eight branches, one providing the skin of the external malleolus, and seven which innervate the dorsum of the toes, each branch providing a half of a toe, beginning at the hallux.

From the head of the fibula to the anterior border of the external malleolus a line is drawn, parallel to the axis of the limb. An incision of ten centimetres involving only the skin is made, on the line mentioned above, terminating four fingers' breadths from the lowest point of the malleolus. Either immediately, or by tearing the loosened borders of the wound, a little to the right or to the left, the twigs of the musculocutaneous nerve, going to the toes, may be observed issuing from an aperture in the aponeurosis, in this case situated in the uppermost part of the incision; or issuing from several apertures, which then are situated one above the other. The upper branches go to the innermost toes (hallux, second toe, internal border of the third). The lower branches are distributed to the external border of the third toe and to the fourth. All spread on the surface of the aponeurosis are perfectly visible and can easily be separated without wounding the superficial veins.

(c) *Exposure of the External Saphenous Nerve*.—This nerve has origin in the popliteal space, descends between the heads of the gastrocnemius in a fibrous channel, leaving this at the middle of the calf and going down through the subcutaneous tissues, along the outer border of the tendo achillis, down to the malleolus. Here the nerve gives several twigs to the outer side of the foot.

It unites at a varying height, but always above the tendo achillis, with the cutaneous branch of the peroneal nerve, the accessorial branch of the external saphenous nerve and the terminal twigs of the small sciatic nerve. At its inner side it is accompanied from the beginning to the end by the external saphenous vein.

The outer border of the tendo achillis is the seat of election to expose this nerve, which has already united with the anastomotic nerves, mentioned above. Besides this, the nerve has not yet given off its branches and is situated superficially. An incision of three centimetres long is made, one finger's breadth external to the outer border of the tendon. The lower end of this incision terminates three fingers' breadth above the top of the malleolus.

The incision is made only through the skin and exposes, in the subcutaneous tissue, the nerve accompanied by the external saphenous vein whose branches cross the nerve vertically and are to be spared as much as possible.

When the desired nerve is exposed, it is lifted up with the finger

or with a grooved director. First it is stretched very cautiously by one finger at the peripheral end, then between two fingers. This is the action of nerve-stretching, in which it is useless to strain violently, especially when stretching for a long time. When it may seem advisable to cause a more intensive reaction in the nerves we may divide them into separate fibres. But we must take well into consideration, that very small nerve-trunks support badly the lacerating action of the small rake, an instrument recommended by Gerard Marchant and Marty, so that caution may be exercised in stretching the plantar, musculocutaneous or external saphenous nerves. I prefer an exploring needle to the rake, because the effect of the one-pointed instrument may be watched much better and, if necessary, may easier be modified than the action of the many-pointed rake. Lacerating the larger trunks with a rake offers no difficulties. The sciatic nerve may be teased with any more or less pointed instrument, even by a grooved director.

The second division of the second stage of the operation consists in the immediate treatment of the sore. When the sore is too extensive or when the surrounding skin is too much implicated, the surgeon must be satisfied with refreshing the edges of the wound and opening up the usually funnel-shaped sore with the sharp spoon, by removing all disintegrated and necrotic debris from the bones as well as from the soft parts.

When, however, it is possible to excise the sore entirely and to remove the affected tissue from the surface to the base and to leave only sound and bleeding tissues, it may be possible to bring together the borders of the wound with deep sutures and to unite the skin with a set of fine stitches.

In this way the wound often heals by first intention, and this restoration may be more regularly obtained than one might believe. With patience the borders of these oblique funnels can be brought together, even when they occupy a third of the circumference of the ankle, or are situated in the sole, if their diameter amounts to two or three centimetres. Gradually the skin closes as a result of the tension of the deep sutures and it becomes possible to suture the skin with fine stitches, and, although under strain, necrosis of the skin is of rare occurrence. The only cause of ill success in obtaining healing by first intention is an insufficient disinfection of deeper parts of the *malum perforans*, but to secure this disinfection, we have the first stage of the treatment, and if care is taken, a failure is very seldom seen.

It is evident that no treatment of the sore takes place and that the ulcer and its neighborhood is kept dressed as long as the nerve operation

is being performed and till the wound is sutured and covered with an occlusive dressing.

We may without difficulty convince ourselves, by a perusal of the literature on this subject since 1852, that a permanent cure of perforating ulcer is not to be obtained by conservative treatment. So it was with the several ancient methods of treatment. And what can be attained with the modern methods, laid down in the literature of late years? Let us submit some of the recent publications to a trial.

Müller (*Deutsche Medizinische Wochenschrift*, 1912) recommends treatment with zinc peroxide. After having washed the sore with a solution of hydrogen peroxide, he applies zinc peroxide powder and dresses with a simple ointment. He succeeded in closing the wound, but the anæsthesia and analgesia remained as before. He does not mention relapses taking place.

Courbon (*Semaine Médicale*, 1913) treated with iodine vapor, but the sore only improved; no cure was attained.

Boziès (*Gazette des Hôpitaux*, 1913) publishes four cases, treated by hot air, which ameliorated, but were not cured. In the fourth of the published cases he had to amputate, because the patient, affected with diabetes, became cachectic and did not react to the "Föhn" treatment.

If these are the only results of the modern treatment, we may conclude that it is of no more use than the older méthodes.

It is evident, therefore, that nerve-stretching or its modifications is of much more use in support of purely surgical treatment of these ulcers—I refer to my series of cases as tabulated at the end of this paper.

Generally speaking, nerve-stretching is not adapted to the benign cases mentioned by Tillaux. In such cases, in my surgical practice in Europe, I never proceeded immediately to the nerve operation, unless at the same time trophoneurotic, or in general, nerve disorders were diagnosed. In those cases a thorough surgical treatment of the malum was carried out, affected tissues were removed with the sharp spoon and chisel, the projecting points of the joints being chiselled away, when they might exercise pressure on the soft parts; and then foot-gear that fitted the deformed feet and that corrected the gait were ordered.

Such mala perforantia may be cured in this way—this is a well-known fact, which persuaded Lange in his dissertation, composed under the ægis of A. Köhler and Hildebrand (Berlin, 1914), to recommend this method as a general treatment of malum perforans. But in the majority of cases, relapses occur.

In tropical practice it is necessary to have an earlier recourse to nerve operations, especially when, as in my Central Hospital, dealing

with a native coolie population, which does not understand and which does not desire to use orthopædic appliances, not even shoes.

When considering mala perforantia merely as sores, spreading deeper and quicker than ordinary sores, and not keeping in view the nerve disorders as being the cause of these sores, we might be persuaded into treating them without nerve operations, but in this way we shall not attain a lasting cure. Relapses are sure to occur, as experience shows, while by applying the nerve operations, whether nerve-stretching or nerve-lacerating, relapses are almost never noted.

As a rule, my incision to expose the nerve was made at a greater distance from the sores, as suggested by Chipault in his publications. He pronounced the operation of choice to be nerve-stretching of the nervi plantares. As may be seen from my tabular statement, although my operation was usually made at a greater distance, I noted cases in which even this operation proved to be insufficient, and ought to have been supplemented by an operation at a still greater distance.

Amongst others who have had the above failures and successes is Bethag (*S. Jahresbericht für Chirurgie*, 1906). He twice uselessly stretched the plantar nerves, and found on operating further, and examining microscopically pieces of the tibial nerve removed, that the latter was altered. Properly speaking, it was therefore impossible to expect good results from his stretching operations.

It is obvious that the nervous disorders, as far as they can be identified, ought to indicate the spot where the operation must be made. I had better and quicker results with fewer relapses in my nerve operations, when deviating from the rules suggested by Chipault, who urged that stretching of the plantar nerves was the normal operation in cases of mal perforant plantire; and lacerating operations, instead of stretching, gave still better results.

When we find, contrary to the results of simple surgical interference with these ulcers, that after nerve operations relapses do not occur, we may conclude that these nerve operations have a favorable influence on the nerve disorders which caused the wrong position of the foot, the wrong gait and, by mechanical and trophoneurotic disturbances, the perforating sore.

Indeed, when I may be guided by some cases in my tropical practice, the effect of nerve-stretching is markedly successful in paresis of the peroneal nerves in beriberi; lacerating operations are still more strikingly successful. After all, far be it from me to suggest nerve-stretching or lacerating to be a method of treatment in the neuritis of sufferers from beriberi. As such I never performed the operation, and have not

had the opportunity for it, because in the last two years no new cases of beriberi have been admitted to the Central Hospital.

Besides this I must emphasize the fact that in cases in which I did not stretch, but teased, the nerves, the pains and neuralgias, which Chipault spoke of in his publications, did not occur. I lay stress upon this, because it seems to me that lacerating has a more intense action on the diseased nerves. Yet I will at once admit, a mere nerve-stretching in many cases has proved to be satisfactory, when executed at the right distance from the sore. When obliged by the condition of the malum perforans, or by trophoneurotic disorders of the skin in its neighborhood, to operate at a great distance from the sore, I believe it will be preferable, not to stretch, but to perform a lacerating operation.

I will abstain from giving averages or percentages derived from a relatively small number of observations. I shall confine myself, mentioning in the subjoined statement the forms of diseases from which those patients were suffering and were treated by nerve operations from malum perforans.

In Table I at the end of this paper, the principal particulars are further combined. As the title already mentions, it is not my intention to give in this paper a complete treatise on malum perforans. Hence, only those cases are made mention of which were treated by nerve operations.

Treated by nerve operations:

| | |
|-------------|----|
| Men | 23 |
| Women | 2 |
| | — |
| Total | 25 |

These 25 patients were suffering from:

| | |
|---|----|
| Diabetes | 4 |
| Alcoholism | 2 |
| Diabetes and alcoholism..... | 2 |
| Diabetes and arteriosclerosis..... | 1 |
| Alcoholism and injury of sciatic nerve..... | 1 |
| Alcoholism and injury by a shoe nail..... | 1 |
| Tabes | 2 |
| Syringomyelia | 1 |
| Typhus | 1 |
| Typhoid | 1 |
| Beriberi | 8 |
| Spastic spinal paralysis | 1 |
| | — |
| Total | 25 |

PERFORATING AND VARICOSE ULCERS OF THE LEG

In all cases medical attendance began with surgical treatment of the malum perforans and a rest cure. Only when this treatment did not result in healing, I passed to stretching or laceration of the nerve-trunk in the region of which the malum perforans was situated.

This operation was always accompanied by a further thorough surgical treatment and extirpation of all the diseased parts. If such operations proved insufficient and in cases of relapse, the nerve operation was repeated at a higher level, generally not as nerve-stretching, but as nerve-lacerating. In this way were performed in 25 patients 33 nerve operations, by which the mala perforantia finally were cured.

Here I lay stress upon two facts:

(1) The mere local surgical treatment was shown to be useless in all these cases, even when combined with an absolute rest-cure.

(2) The same surgical treatment combined with a nerve operation, whether executed once or repeatedly, always led to cure.

Naturally, the ultimate fate of these sufferers from central nervous diseases is not discussed here; it is evident that such central disorders cannot be influenced by peripheral operations.

The tabular statement below gives details of 33 nerve operations performed on 25 patients suffering from perforating ulcer.

Nerve-stretching:

| | |
|-------------------------------|----------|
| External saphenous nerve..... | 16 |
| Posterior tibial nerve..... | 4 |
| Musculocutaneous nerve | 1 |
| Plantar nerve..... | 3 |
| | <hr/> 24 |

Nerve-lacerating:

| | |
|-------------------------------|---------|
| External saphenous nerve..... | 1 |
| Posterior tibial nerve..... | 3 |
| Musculocutaneous nerve..... | 1 |
| Plantar nerve..... | 1 |
| External popliteal nerve..... | 2 |
| Sciatic nerve | 1 |
| | <hr/> 9 |

| | |
|------------|----------|
| Total..... | <hr/> 33 |
|------------|----------|

II. CHRONIC VARICOSE ULCER

This ulcer is similar in many respects to perforating ulcer of the leg and foot, but the alterations in the vessel walls play a much more important part than they do in perforating ulcer.

A number of accessory signs hint in the direction of trophic dis-

orders, and those who have realized the excellent results afforded by a judicious combination of nerve-stretching with routine treatment have taken up this combination in the treatment of varicose ulcers and not in vain. Several observers have pointed out the sensory and secretory phenomena accompanying varicose sores. But the signs of morbid processes in the skin in the neighborhood of the sore yet more obviously bear a trophic character, even up to a combination with *malum perforans*, as has been demonstrated by Tuffier and Chipault; or showing trophic disorders of the bones as described by Reclus; or perifascicular interstitial neuritis as mentioned by Cornil and Ranvier and examined by Quénu and Gombault.

Therefore it is evident that relations of a trophic nature are to be accepted between chronic varicose sores and *maux perforants*. Besides this, every endeavor to treat the despair of all hospitals, the chronic varicose ulcer, with more chance of success must be welcomed with joy, especially when the method of treatment is dependent on the pathogenesis of the disease, which has hardly hitherto been the case. Indeed, the extensive, nearly endless literature on chronic ulcers of the leg, the laudatory commendations of continually renewed remedies, prove beyond doubt that a passion for using powders and ointments put us off the track. A specific remedy will never be found, though one drug may have an apparent advantage above another; the manufacturers derive the most profit from it, the patients the least.

It may be taken as certain that, however manifold the causes of varicose ulcers of the leg and lower extremity may be, their pathology is obscure, to us as well as to Hippocrates (*οἱ Κίρσοι*). It is true that mechanical causes, prohibiting the back flood of venous blood, assume a great part in the etiology of the varices, as also of the varicose sores; but this was already as well known to Oribasius as to us.

Mechanical hypotheses hardly account for varicose veins and for the resultant ulcers; we often fail to find varices in large abdominal tumors accompanied by high intra-abdominal pressure: varicose veins and their skin lesions are as frequent in Europeans as they are rare in Malays and Javanese.

In rather more than a year I have only seen one case of varix combined with a varicose ulcer in over 200 Javanese women confined in hospital. No grave case of varix and no case of varicose sore occurred in 13,260 Javanese coolies admitted during the past two years. The cases of varicose ulcers that I observed in the Dutch East Indies concerned chiefly Europeans, Chinese and Japanese and, exceptionally, natives, *i.e.*, Javanese.

PERFORATING AND VARICOSE ULCERS OF THE LEG

It is evident that other than mechanical factors must here take the lead. And so the nutritional disorders of, and the pains in, the lower extremities, out of proportion to the extent of the varices or of the sores, give a hint as to a nervous causation.

By this is explained that powders and ointments, whatever their nature, are not alone able to cure a varicose sore. By treatment of the varix, we have an expedient for treating varicose ulcers, but not a permanent remedy; and the causative trophic disorders are outside the power of such remedies.

But it is also evident that, in cases in which the long lasting affection has caused considerable mechanical disorders of a permanent nature, it will be impossible to nullify these mechanical disorders by a simple treatment of the trophoneurotic disorder. In these cases it is necessary to treat the trophoneurosis; but besides this, the varices also require surgical treatment. Without this it will be impossible to obtain a lasting cure without or with little chance of relapse.

As to the technical part of the treatment; it will be necessary to pay attention to a previous thorough disinfection, preceding the operative treatment. Dressing with a solution of 1 per cent. potassium permanganate proved very useful in this preliminary treatment, but still more useful were dressings of a solution of hydrogen peroxide. This solution gives evidence of similar advantages as I have observed with it in the treatment of tropical sores. It is not only a powerful disinfectant, but an anodyne also. It is evident this remedy cannot cure, it is only useful in the preliminary disinfection of the sore.

This preliminary treatment having been accomplished, we begin with the second stage, as in the treatment of *malum perforans*, to be executed in two divisions—first the nerve-stretching, then the direct treatment of the sore.

Chipault urged very rightly that this stage of the treatment should be executed under general narcosis. Local anæsthesia is not suitable to the purpose and anæsthesia of the spinal cord is contra-indicated, because dilated epidural venules, or the like, of the pia mater often occur in sufferers from varices, as Chipault and Manoury have shown, and these conditions are a special contra-indication to this form of anæsthesia.

The nerve-stretching must be applied to the nerve in the region of which the sore is situated, and should not be performed too near to, nor too far from, the sore. When the incision is made too near the sore, we might operate in œdematous or sclerotic tissues and it is possible then to stretch a nerve-branch whose area of supply is too limited. When nerve-stretching is performed too far from the sore, the trophic effect

of stretching may be nullified. It is therefore necessary to select the external saphenous nerve or the musculocutaneous nerve; at all events nerve-roots of the same relative size. But besides this, it is better in cases of extensive varicose sores to *substitute stretching of the external popliteal nerve for stretching of the musculocutaneous nerve*, because the anterior tibial nerve distributes branches, which lie in more superficial layers above the region of the musculocutaneous nerve, and, moreover, provide the deeper layers. It is important to bring these regions under the influence of stretching, in order to act on the terminal branches innervating the coats of the varices in the muscular tissues.

The following nerves come under consideration for nerve-stretching in the neighborhood of the sore: (a) *Internal saphenous nerve*; (b) *external popliteal nerve*; (c) *external saphenous nerve*.

The technic I have followed in exposing these nerve branches is mentioned below, and is the same as suggested by Chipault in his *Traité de Chirurgie du Système nerveux*.

Teasing the sciatic nerve into separate fibres is an operation I have very often performed, always selecting the classic spot on the lower border of the glutei—it is not necessary to detail this well-known operation.

(a) *Internal Saphenous Nerve*.—By exposing this nerve when it leaves the femoral canal, it is possible to bring all the cutaneous twigs, collateral and terminal, under the influence of nerve-stretching. The best way is that indicated by Letiévart. The place of choice lies a little beneath the point where the nerve leaves the crural canal and is situated on the adductor magnus, covered only by the outer border of the sartorius. Then the leg must be laid on its inner side and the outer border of the sartorius must be searched for and an incision about six centimetres long must be made along this border, but a little more internally. The end of the incision reaches the lower third of the thigh. Then an incision is made in the sheath of the sartorius and the muscle is drawn toward the inside with a blunt hook. In this way a hollow sheet of fascia is exposed, corresponding with the furrow which separates the vastus internus from the adductor longus, and finally the tendon of the latter is seen. At this spot the white shining tendon of the adductor magnus is easily found, on following down the tendon of the adductor longus. The nerve crosses the tendon of the adductor magnus and may be recognized by its dead white color and the direction of its bundles.

(b) *External Popliteal Nerve*.—This nerve can be exposed at several places. When it is not only intended to act upon its terminal twigs, the musculocutaneous and posterior tibial nerves, but also upon the com-

municating peroneal branches, in whose area of supply sores are extremely rare, it will be necessary to expose the nerve above the hollow of the knee, because the communicating branches originate irregularly, their course being for some time parallel to the external popliteal nerve. For this the patient is placed in the prone position. The operator stands at the outer side, flexes the knee and marks the fold. The limb being extended again, he palpates the inner border of the biceps femoris and makes an incision of five centimetres long terminating, according to the side on which the operation is performed, at the right or at the left, two fingers breadth above the knee-fold. The skin, subcutaneous tissues, and aponeuroses are successively and carefully divided with a knife, to spare the cutaneous branches distributed here. Then the inner border of the biceps may be perceived and, as the flexion of the limb facilitates the action of drawing this muscle outwards, the external popliteal nerve and its collateral branches are soon discovered, whether at their origin or, when they divide higher up, during their course parallel to the trunk of origin.

When it is intended to act only on the two terminal branches, excluding the communicating twigs, we expose the external popliteal nerve at the head of the fibula, either behind or beneath.

(a) The best way to expose the nerve at the back of the head is suggested by Velpeau. The slightly flexed leg is laid down on its inner side. An incision is made from the beginning of the anterior interosseous space, to the end of the popliteal space. This incision follows the depression which separates the tendon of the biceps femoris from the gastrocnemius, and thereupon crosses the outer side and the front of the fibula, immediately above the head of this bone. To reach the nerve, the surgeon must divide the skin, the subcutaneous fascia and the aponeurosis. The tissues are separated by a probe, and the nerve trunk is easily found between the outer head of the gastrocnemius, below and internally, and the tendon of the biceps with the head of the fibula, above and external; the posterior border of the fibula, or the peroneus longus muscle being visible in front.

(b) The best method to expose the external popliteal nerve below the head of the fibula is indicated by A. Chipault, in his *Chirurgie du Système nerveux*. By this method muscles are least injured. The leg is flexed to an obtuse angle and rests on its inner side, so that the head of the fibula protrudes and may easily be palpated. Beneath this capitulum two intermuscular fascial lines coursing lengthwise are to be distinguished more or less easily. The anterior fascial line lies between the extensor communis digitorum and the peroneus longus and the ex-

ternal head of the gastrocnemi. An incision of four centimetres in length is made in the first intermuscular line, terminating at the base of the head of the fibula: it divides the skin, the subcutaneous tissue and the aponeurosis. Then the foot is flexed and abducted, the extensor digitorum communis is hooked forward and aside, the peroneus longus backward; by this manœuvre the nerve trunk is laid bare, having been covered by the last named muscle. The external popliteal nerve is then exposed at the place where it gives off the musculocutaneous and anterior tibial branches. Obviously nerve-stretching at this place has a greater effect than the isolated stretching of the musculocutaneous nerve.

(c) *The External Saphenous Nerve* (a branch of the internal popliteal) accompanied by the saphenous vein descends along the posterior median line of the leg, first under, then above, the fascia. This nerve takes but little part in the cutaneous innervation of the leg. Only after its union with the tibial communicating does it supply the foot. Hence the surgeon only has to deal with it when the sores are situated very low. See ineffectual stretching of this nerve in a case of sore (tabular statement). The nerve may be exposed without any difficulty. A longitudinal incision is made at the middle of the back of the limb, beginning three fingers' breadth below the furrow of the knee and following the aponeurosis between the gastrocnemi, which sometimes is visible and often is palpable. The incision is made through the skin, the subcutaneous tissue and the fascia, on a grooved probe; then the vein is exposed and at its side, as a rule at the inner side, the nerve may be found without difficulty.

No special difficulties will be met with in finding the nerves. Only, the considerable circumference of the venous trunks in persons suffering from varices, will make it necessary to operate slowly. In cases of hemorrhage every bleeding vessel ought to be ligatured. The nerve-stretching itself is best done by gently teasing the nerve sheath. In varicose disease caution is especially necessary on account of the small size of the nerve-trunks, and also on account of the nerve tissue which is found in this disease.

The sore, if it is not too large nor too deep, should be removed entire and the wound closed by plastic methods, and sutured. Excision of the ulcer, including any diseased skin, leaves a fusiform wound. The incision is extended twenty centimetres upward to prevent strangulation of the limb. The flaps of skin are loosened and adapted to cover the gap left by the excised sore. The incision does not go deeper than the fascia, but the flaps must be loosened very exactly from it. Any eroded or indurated tissue must be removed by the sharp spoon and scissors,

PERFORATING AND VARICOSE ULCERS OF THE LEG

and the fascia thoroughly cleaned. As to the borders of the wound, which often are the source of considerable hemorrhage in consequence of the dilated vessels, it is necessary to ligature every bleeding vessel with thin catgut before suturing the wound. The fascia and wound must be perfectly dry and free from blood. Thereupon a number of long threads are sutured at intervals through the edges of the wound, using round needles and taking care that the stitches are applied symmetrically. Without tearing or straining, the threads are tied successively. The elasticity of the skin of the lower limb is sufficient for a very extensive plastic operation. In order to relieve the tension when it becomes too great, we may make a long relief incision at the back of the calf.

When the sores were not too large, I repeatedly excised the ulcer in a square form, and after having loosened the flaps of the skin I sutured them in the form of a cross, having displaced them toward the cleaned floor of the sore. If the tension was too great, four relief incisions were made, each between the two sides of an angle. These incisions were then sutured across, and I obtained very good results.

The operations mentioned above are not applicable when the sore is too extensive, and it is therefore impossible to cover the defects of the skin by plastic operations; or when the skin in the neighborhood of the ulcer has lost its vitality by trophic disorders and become weakened and atrophic or thickened and indurated. In these cases we must be content with a cleaning up of the sores by the sharp spoon and cutting away the mortified skin with scissors, removing all necrotic tissue and all tissue whose vitality seems diminished. Then we ought to promote the cicatrization by an efficient treatment of the wound. In the first case, the wound heals by first intention, in the second case, healing is obtained by granulation.

It is self-evident that we have the best chance of restoring the wound of the extirpated sore *per primam* when operating on small sores. If we do not waste time with ointments and powders, but immediately institute surgical treatment—that is, efficient cleansing of the ulcers—the majority of them being thus promptly and properly treated will prove to be suited to the operation of nerve-stretching and, as experience teaches us, with good chances of cure.

It is also obvious that this kind of sore requires, like the *malum perforans*, careful after-treatment. To aid the circulation we should raise the affected limb for at least a week. When the wound has closed the patient ought to move about with a dressing that exerts some light pressure. For this purpose, dressing with zinc-oxide-gelatin, as recom-

mended in the old established therapeutics of varicose ulcers, proved to be of great use.

As the British Pharmacopœia, 1914, does not contain an indication of the drugs for preparing this compound, it may be advantageous to give the formula contained in the Pharmacopœia Neerlandica, Ed. IV.

| | |
|---|-----|
| Gelatina oxydi zincici | |
| Solve calore adhibito, in balneo aquæ | |
| Gelatinæ partes viginti | 20 |
| In aquæ partibus quadraginta | 40 |
| His adde | |
| Glycerini partes decem | 10 |
| Solutis admixe | |
| Oxydi zincici partes quindecim | 15 |
| Ante contritas cum | |
| Glycerini partibus quindecim | 15 |
| Et tantum aquæ adde ut totum pondus sit partium | |
| centum | 100 |

I spread a thick layer of this liquefied medicated gelatin over the leg and cover this while still wet with a thin layer of cellulose wadding, which immediately sticks and forms an immovable dressing. Over the ankles the layer of cellulose wadding is made thicker, in this way preventing the bandages from cutting into the skin when the patient walks. Over the layer of cellulose wadding a bandage of well starched gauze adds the finishing touch to the dressing. The patient remains in bed until the dressing is thoroughly dry.

It is necessary to prevent adhesions developing between the superficial and the deeper tissues by systematic massage which has also the effect of restoring the lost elasticity of the skin and the subcutaneous tissues.

Doubtless there remain some cases, although they may be rare, in which the varices have already reached such an extent that mere nerve-stretching without treatment of the dilated veins proves to be insufficient to insure a lasting recovery.

Operations on varix are only to be performed when indicated by vicious conditions, particularly in cases of insufficiency of the valves of the saphenous vein. In these cases it is evident that such operations should also have a beneficial effect on the cicatrization of the sore.

It follows, too, that nerve-stretching may obviate the necessity for operations on veins which have not yet been too much dilated, as this operation is not only beneficial to the actual ulcer, but further has a restorative influence on the varix itself. The further conclusion in rela-

tion to treatment is: not to perform operations on the veins if they are not indicated by the pathological condition of these vessels.

Finally, I must lay stress upon the fact that nerve-stretching does not absolve us from a thorough treatment of the sore. As claimed above, the sore ought to be disinfected with all recognized surgical precautions—the sclerotic and atrophic borders, all the tissues that have lost their vitality must be removed completely. Otherwise the wound might be reinfected, thus delaying the cure and the trophic effect of nerve-stretching and preventing it from exerting its full activity in favor of the process of recovery.

In this connection I may mention that I have performed the operation of laceration of the nerve in several cases of large painful varix; in these cases I have noted that, not only did the pain cease, but that the dilated veins diminished in volume. With Chipault I believe in a trophic influence on the coats of the varicose vessels, but I also believe in the more intensive action of lacerating the nerve-trunk. I have performed this operation many times and never with any harmful result, but always with notable effect.

Peculiar difficulties occurred in the treatment of a case of *ulcus tropicum* which developed in the floor of an *ulcus varicosum* (in a Chinese) externally, between the upper and middle thirds of the right leg. The treatment of the tropical sore was carried out in the usual manner, as I have described in the *Geneeskundig Tydschrift v. Nederl.-Indie*, 1914, p. 709; but without success. This treatment combined with a fenestrated zinc-oxide-gelatin dressing was no more successful. Only after having performed a double ligature of the saphenous vein at the saphenous opening, according to the suggestion of Trendelenburg, and after having resected pieces of the vein, did the sore show signs of getting clean while still exhibiting the well-known characteristics of a chronic tropical sore. Supposing trophic disorders yet continued their ill effects on the varices in the neighborhood of the sore, thus preventing its cure, I, led by my experience of the effect of nerve operations, exposed and lacerated the sciatic nerve and again cleansed the ulcer with sharp spoon and scissors. The sores did not heal till this was done. But this stage also gave me difficulty. Cicatrization made indifferent progress and this induced me to cut out the ulcer and to do a plastic operation, known by the name of “*forming living elastic stockings*.” The sore was excised as a square; the skin sufficiently loosened to allow the flaps being brought into contact and sutured in the form of a cross, without too great tension. To diminish the tension, a relief incision was made from each of the angles of the square; and between them

four small incisions parallel to the sides of the square were made. In this manner the wound was easily covered with sound skin and made a good recovery by first intention, the scars being solid without being tense. Such flaps always heal up well, as experience has taught me in many cases, and they give the considerable security against the subsequent breaking open of the cicatrices. The whole treatment demanded about three months.

It would be useless to publish detailed records of all my operations. I have therefore tabulated them, as I have done with my cases of *malum perforans*, at the end of this paper. The case I have described above is related to a peculiar combination with an infection of the varicose sore by the symbiosis of Le Dantec-Vincent; and I refer those who wish to know more about my clinical observation on tropical sores to my paper on this subject, to be found in *Geneeshundig Tydschrift voor Nederlandsch-Indie*, 1914, p. 674.

Table II gives notes of patients treated by nerve operation for varicose sores:

| | |
|-------------|----|
| Men | 7 |
| Women | 11 |
| | — |
| Total | 18 |

In these 18 patients were performed the following 21 nerve operations:

Nerve-stretching:

| | |
|--------------------------------|-----|
| Internal saphenous nerve | 3 |
| External saphenous nerve | 1 |
| External popliteal nerve | 3 |
| | — 7 |

Nerve lacerating:

| | |
|--------------------------------|------|
| Sciatic nerve | 13 |
| External popliteal nerve | 1 |
| | — 14 |
| Total | 21 |

These figures show, in the treatment of varices, that I disagree with the rules given by Chipault. My experience gives me the right to participate in the view of P. Delbet, that operations on the sciatic nerve are the most favorable method of treatment here. These operations on the sciatic nerve are emphatically to be preferred in varices which are of trophic origin, as evidenced by their beginning, course, and development, and by the tendency of their resulting sores to relapse, and

such varices need not only be superficial; internal varices may also be accompanied by trophic ulcers, this being so that any nerve operation must be performed on that part of the nerve which is above the origin of the divisions to the areas of supply in question.

Lacerating the sciatic nerve is sufficiently radical to be followed by an action on its most distant branches. Simple nerve-stretching has by no manner of means such an effect. The action provoked in the nerve-trunk lasts during the cicatrization of the teased nerve-fibres and gives evidence of its reaction on the whole nerve region for a long time. Without any doubt this operation is more efficacious than stretching operations at ordinary distances. By stretching, connections with branches situated above the place of stretching are left untouched, and therefore no curative effects can be expected on varices lying more centrally.

It cannot be denied, my own observations are sufficient to prove it, that the varicose sore and also the varices, when not too far advanced, may be cured by thorough surgical treatment, accompanied by simple ligation of the saphenous vein.

But, if it is impossible to eliminate the harmful trophic effects of a varix on its accompanying ulcer, we cannot expect a lasting cure of the ulcer.

In a review of the progress of modern surgery in the treatment of varices, apart from nerve operations, it must be admitted, as in the publications of Goerlich (*Bruns: Beiträge zur klinischen Chirurgie*, Bd. 44), that only 27 per cent. of the cases are cured and 73 per cent. are improved or lose the subjective symptoms complained of by the patient.

It is evident that the multiple ligation of varicose veins, the technic of which was introduced by Schede and Kuzmik and applied in 155 cases by Secher (*Hospitalstidende*, April, 1915), is only meant for favorable cases. Under general anæsthesia a silk suture (Kuzmik) or catgut (Schede) is passed around the vein, without exposing the vein, and this is repeated at intervals of 2 cm. (Schede) or of 5 cm. (Kuzmik). It is also evident that this method does not reckon with the etiology of varix and cannot be called an improvement.

For difficult cases remains total excision, according to Madelung; but a partial excision of the principal trunks of the dilated veins is also recommended.

According to the figures, published by Stein in his dissertation (*Bostock*, 1902), 50 per cent. of the cases treated after Trendelenburg's method and 80 per cent. after Madelung's method, were cured. Kocher (*Operationslehre*, 1907) suggested a neutralization of the hydrostatic

pressure by tying the vein as high up as possible, to prevent this pressure being exerted through the side branches.

But the percentages of cure, attainable by the well-known methods of treatment, mentioned above, make it clear that improvements are required in the treatment of uncomplicated varices, as in cases complicated by sores.

In my opinion we went astray in these endeavors. Without mentioning the nerve operations, which have not found many partisans except in Latin countries, we have been able to eliminate many imperfections in the operations of extirpation; but the figures quoted above are evidence that modern surgery ought not to be content with simple extirpation of varices, after Madelung's method. This operation, a radical method, founded on sound principles, gives, in my experience, as much as may be attained by an extirpation. It is absolutely incomprehensible, why this harmless operation should be replaced by methods which cannot stand the criticism of general pathological principles. I mean the operations of Tavel (*Deutsche Zeitschrift für Chirurgie*, Bd. 109, earlier published by him in *Correspondenzblatt für Schweizer Aerzte*) and the operation of Mamourian, performed and the results published by Orloff (*Virchow-Hirsch Jahresbericht für 1913*).

Tavel ties the long saphenous vein and excises, quite near the femoral vein, a piece five centimetres long. One or two days after the operation, he injects every two or three days a dose of 10 cubic centimetres of an aqueous solution of carbolic acid into the tortuous vein, if possible into the lumen of the vessels. In this way an artificial thrombus is formed, as also by injections external to the veins; these, however, are more painful and may cause a gangrene of the covering layers of the skin.

By the formation of a thrombus a danger always threatens, as Kocher saw after an operation by which he removed parts of varicose tumors in the calf and performed a high ligation of the long saphenous vein. Getting up from bed, the patient suddenly died from an embolus of the pulmonary artery. This case proves that a ligation of the long saphenous vein is unable to prevent a thrombus formed in the veins of the leg from being carried to any distant vessel and obstructing the circulation there.

Mamourian exposes the long saphenous vein in the fossa ovalis and ties the vessel centrally, seizing it peripherally with a pressure forceps. Then the same vein is exposed temporally above the knee-joint, ligatured peripherally, and seized centrally with a pressure forceps. From this place a large, long probe is introduced into the lumen of the vein, so that this probe appears in the fossa ovalis. The peripheral end is fastened to

PERFORATING AND VARICOSE ULCERS OF THE LEG

the eye of the probe and by pulling and inverting, the vessel is drawn out and removed. Orloff operated thus on three cases with good results. Contra-indications are: inflammations, thrombosis, strong cicatrizations, weak and thin coats of the veins.

The mere mention of these modern methods already teaches enough; they are not improvements in the treatment of varices and are without any importance in the treatment of varicose sores. These methods no more reckon with the etiology than do the methods of Trendelenburg and Madelung, which are easier and better.

That is how the matter stands at present; and therefore I submit that the only modern surgical method of treatment that reckons with etiology is local treatment of the sore combined with stretching or laceration of the nerve, in the region of which this sore is situated.

TABLE I
MALUM PERFORANS

| Sex | Age | Race | Etiology | Surgical clinical symptoms | Operation | Results | Remarks |
|-----|-----|------|--|--|---|--|---|
| M | 65 | E | Diabetes, alcoholism | Perforating sore under metatarsophalangeal joint of right great toe | Nerve-stretching of plantar nerve at its origin, appropriate disinfection and preparation of the sore, removal of necrosed bone, excision of disintegrated tissues; suture | Healing of the wound by first intention. | |
| M | 69 | E | Diabetes | Malum perforans under left heel extending to the os calcis | Nerve-stretching of posterior tibial nerve; cleansing the sore; removal of necrosed bone | Healing | Too near the malum perforans to stretch the plantar nerve. |
| M | 63 | E | Tabes parasyphilis | Behind the head of the fifth metatarsal bone | (1) Nerve-stretching of external saphenous nerve; cleansing the sore with removal of the necrosed bone. (2) Stretching of tibial nerve; resection of the affected head | After (1) healing, but after 3 months relapse at the same place; after (2) cure. | |
| M | 65 | E | Syringomyelia | (1) Trophic disturbances of the right foot, multiple sores, oedema, malum perforans under head of first metatarsal bone (2) Relapse at the heel, rapid necrosis of os calcis and astragalus (3) Relapse at fifth metatarsophalangeal joint | (1) Nervi plantares stretched at their origin beneath the malleolus (2) Mikulicz's tarsectomy | Healing, but after 2 months relapse at the heel. | |
| M | 47 | E | Alcoholism | Perforating sore under fifth right tarsometatarsal joint | (3) Stretching of internal saphenous nerve, cleansing the sore and removal of necrosed bone Stretching of external saphenous nerve; cleansing the sore and removal of necrosed bone | Healing after a year; relapse at (3). | Half a year after operation death resulted from bulbar paralysis. |
| M | 67 | E | Diabetes | Perforating sore, inner side of right great toe and between second and third | Stretching of posterior tibial nerve; cleansing the sore and removal of necrosed bone | Healing. | |
| M | 72 | E | Diabetes and arteriosclerosis | Outer side of the little toe | Stretching external saphenous nerve; cleansing sore, removal of necrotic bone; head fifth metatarsal bone chiseled away | Healing. | |
| M | 45 | E | Alcoholism and injury of sciatic nerve | (1) Oblique gunshot wound of left sciatic nerve; necrosis of left great toe (2) After a month malum perforans under head of first metatarsal bone | (1) Arthrectomy of this toe, liberating the nerve from its fibrous adhesions to neighboring tissues (2) Splitting up the sciatic nerve at the seat of injury into its fibres; cleansing the sore; removal of necrotic bone | Recovery after a month malperforant Healing. | |

PERFORATING AND VARICOSE ULCERS OF THE LEG

| M | 60 | E | Diabetes | Two perforating sores—(a) one under the right hallux; (b) one at the outer side of the little toe | (1) Stretching of plantar nerve at its origin beneath the inner malleolus. Cleansing of both the sores and the necrotic bones. (2) Stretching of external saphenous nerve. Again cleansing of b. and removal of necrotic bone of the head of fifth metatarsal bone Lacerating posterior tibial nerve. Cleansing the wound and removal of necrotic bone of the head of first metatarsal bone Lacerating the posterior tibial nerve on both sides with an exploring needle; removal of the necrotic bone with sharp spoon and chisel; cleansing of the sores | (a) Healed; (b) after a month not yet healed. Healing. |
|---|----|----|--|--|---|---|
| W | 50 | E | Alcoholism, injury by a shoemill | Under left great toe a perforating sore | | Healing. |
| M | 22 | E | Typhus, after which paralysis of the nervi tibiales with pes valgo calcaeus | On both soles of the feet at the inner part of the os calcis a perforating sore with necrosis of the bone visible in the depth of the sore | | Healing. |
| M | 25 | E | Paralysis of right nervus peroneus with pes varo equinus recurring after typhoid | Sore under the head of fifth metatarsal bone. Necrosis of the same head | Lacerating the external saphenous nerve with a pointed probe; removal of the necrotic head; cleansing the wound, sutured with three stitches | Healing per primam intentionem. |
| M | 20 | J | Beriberi paralysis of nervi peronei, pes varo equinus on both sides | Sore under head and at the outer side of fifth metatarsal bone, right and left | Stretching of both nervi sapheni externi. Cleansing of the sores. Removal of necrotic bone | Healing. |
| M | 25 | J | Beriberi paralysis of both nervi peronei; pes varo equinus on both sides | Sores under head and at the outer side of fifth metatarsal bone, right and left | Stretching of both nervi sapheni externi; cleansing of the sores; removal of the necrotic bone | Healing. |
| M | 50 | J | Beriberi paralysis of nervi peronei on both sides, pes varo equinus on the left side | Sore under left head and at the outer side of the fifth metatarsal bone | Stretching of the left external saphenous nerve; cleansing of the sore; removal of necrosed bone | Healing. |
| M | 45 | Y | Beriberi paralysis of nervi peronei on both sides; pes varo equinus | On both sides sores under head and at the outer side of fifth metatarsal bone | Stretching of both the external saphenous nerves; cleansing the sores; removal of necrosed bone | Healing. |
| M | 60 | Ch | Beriberi paralysis of both nervi peronei and pes varo equinus on both sides | On the right side ulcer 5 cm. broad under head and at the outer side of fifth metatarsal bone | Stretching of right external saphenous nerve; resection of head; cleansing the wound, sutured with 3 stitches | Healing per primam intentionem. |
| M | 50 | Y | Beriberi paralysis of nervi peronei and pes varo equinus on both sides | On the right side perforating sore under head and at the outer side of fifth metatarsal bone | Stretching of right external saphenous nerve; cleansing the wound; removal of necrosed bone | Healing. |

TABLE I—Continued
MALUM PERFORMANS

| Sex | Age | Race | Etiology | Surgical clinical symptoms | Operation | Results | Remarks |
|-----|-----|------|---|---|--|--|---|
| M | 30 | Y | Beriberi paralysis of nervi peronei; on both sides | On the left side perforating sore under head and at the outer side of fifth metatarsal bone | Stretching of left external saphenous nerve; cleansing the wound; removal of necrosed bone | Healing. | |
| M | 55 | Ch | Alcoholism | Perforating sore under first phalanx right great toe; necrosis of this phalanx | Lacerating the right plantar nerve; at its origin beneath the malleolus; removal of necrosed first phalanx; cleansing and closing the wound with 3 stitches | Healing per primam intentionem. | |
| M | 53 | Ch | Diabetes | Two perforating sores—(a) under little toe; (b) under head of the second metatarsal bone. Both at the right side; eczema of the feet and ankles | Lacerating the posterior tibial nerve; cleansing the wounds; removal of necrotic bone with sharp spoon; treatment of these wounds with tinct. peroxide and of the eczema with Lassar's paste | Healing per secundam in 4 weeks. | |
| M | 45 | Ch | Diabetes and alcoholism | Perforating sore on the dorsum of the third, fourth and fifth toes of the left foot penetrating into the metatarsophalangeal joint of the fourth toe | Lacerating the musculocutaneous nerve with a fine pointed probe; cleansing the wound with sharp spoon and scissors; removal of necrotic bone from the fourth metatarsal bone | Healing. | |
| M | 50 | E | Locomotor ataxia; parasyphilis | Perforating sore under head of first metatarsal bone on the left; necrosis of a part of this head. The sore is fusiform. The probe penetrates $1\frac{1}{2}$ cm. into this bone | Stretching of the posterior tibial nerve; cleansing the sore; subperiosteal removal of necrotic bone with chisels, amounting to a third of first metatarsal bone | Healing. | |
| M | 30 | Y | Spastic spinal paralysis; pes varo equinus of both feet | (1) Perforating sore on the dorsum of the fifth and fourth right metatarsal joints, probe penetrates into the head of fifth metatarsal bone; anesthesia only of the sore, not in its neighborhood. (2) Relapse at the same place | (1) Stretching of musculocutaneous nerve; cleansing the wound; removal of necrosed bone (2) Lacerating the external popliteal nerve. Again cleansing the wound. Reflection of head of fifth right metatarsal bone; suture | Healing, but after three months relapse. | Still in hospital for his spastic spinal paralysis. |
| M | 25 | J | Beriberi paralysis of nervi peronei on both sides; pes varo equinus on the right side | Perforating sore at the outer side of the right little toe After operation the sore spread quickly into the joint; necrosis of the toe | (1) Stretching the external saphenous nerve, scooping out the sore (2) Lacerating the external popliteal nerve. Arthrectomy of necrosed toe; wound sewn with 3 stitches | No result Wound healed per primam intentionem | Still in hospital for his paralysis. |

PERFORATING AND VARICOSE ULCERS OF THE LEG

TABLE II
ULCUS VARICOSUM

| Sex | Age | Race | Etiology | Clinical symptoms | Operations | Results | Remarks |
|-----|-----|------|----------------------------------|---|--|--|---------|
| W | 45 | E | Varices after pregnancy | Varicose sore on the outer side of the back of left lower leg | (1) Resection of the internal saphenous vein, thorough disinfection with a solution of hydrogen peroxide. (2) Laceration of the sciatic nerve; cleansing the ulcer and removing the undermined skin with sharp spoon and scissors | No result. Healing per secundam. | |
| W | 50 | E | Varices resulting from pregnancy | Two sores on the inner side of the right lower leg | Resection of the internal saphenous vein; sciatic nerve lacerated; both the sores cleansed | Healing by second intention. | |
| W | 65 | E | Varices after pregnancy | For fifteen years a varicose ulcer, 6 x 3 cm., above the internal malleolus of the right leg | Resection of internal saphenous vein; laceration of the sciatic nerve; sore cleaned up with sharp spoon and scissors | Healing by second intention. | |
| W | 70 | E | Varices | Inner side of the left lower leg | Resection of internal saphenous vein; stretching of internal saphenous nerve; cleansing the sore | Healing by second intention. | |
| M | 75 | E | Varices | A sore in the middle of the right calf 8 x 4 centimetres in dimension. Above this sore a varicose tumor | Resection of the varices between a ligature above and below the varicose tumor. Sore cleaned up with sharp spoon and scissors; laceration of the sciatic nerve | Healing by second intention. | |
| M | 45 | E | Varices | Varicose sore, 3 x 6 cm., on the lower outer part of the left leg | Disinfection of the sore with a solution of hydrogen peroxide; extirpation of the base of the sore; excision of the sore; loosened skin flaps drawn over cleansed base of ulcer; suture; laceration of sciatic nerve | Healing by first intention. | |
| W | 60 | E | Varices | 7 x 5 cm. sore on the front, inner side of the right lower leg | (1) Sore cleansed; internal saphenous nerve stretched (2) Sciatic nerve lacerated; sore cleaned again with sharp spoon and scissors | Recovery and relapse in 3 months. Healed. | |
| W | 56 | E | Varices | Sore 3 x 4 cm. on the outer side of the right lower leg, below the ankle | (1) External saphenous nerve stretched; sore cleansed with scissors and sharp spoon (2) External popliteal nerve stretched; sore again cleaned up | No results. Healed. | |
| W | 10 | E | Varices after pregnancy | Left inner ankle | Internal saphenous vein ressected; internal saphenous nerve stretched; extirpation of the sore, plastic covering of the defect of the skin by forming "living elastic stockings" | Healing per primam intentionem. | |

TABLE II
ULCUS VARICOSUM

| Sex | Age | Race | Etiology | Clinical symptoms | Operations | Results | Remarks |
|-----|-----|------|---|---|---|---|--|
| W | 42 | E | Varices after pregnancy | Lower outer part of left calf | (1) External popliteal nerve stretched; sore cleaned up with sharp spoon and scissors (2) Sore again cleaned up; laceration of sciatic nerve | (1) Recovery and relapse in 1 month. (2) Definite recovery. | |
| M | 57 | E | Varices | Lower outer side of right calf; sore 7 x 5 cm.; large dilated varices on the inner side of the knee | Excision of the sore; extirpation of the bunch of varices, after having placed a ligature above and below; plastic covering of the defect by loosened flaps of skin; laceration of sciatic nerve | Healing by first intention. | |
| M | 46 | E | Varices | Lower part of right calf | External popliteal nerve stretched; sore cleaned up by sharp spoon and scissors | Healed. | |
| M | 62 | E | Varices | At left malleolus internus | Excision and extirpation of the sore; plastic covering of the square defect—four relief incisions between the sides of the angles; lacerating the sciatic nerve | Healing by first intention. | |
| M | 35 | Ch | Varices complicated by tropical sore (see page 567) | Outer side between upper and middle third part of the right lower leg | Ulcer cleaned up; varices extirpated; sciatic nerve lacerated; plastic covering of the square wound, forming a living elastic stocking | Healing after treatment for 3 months | Published in extenso in <i>Tydschrift v. Nederl. Indie</i> , 1914, page 674. |
| W | 42 | E | Varices | On and above right malleolus internus, 6 x 4 cm. | Extirpation of sore by elliptic incision, plastic covering by the loosened flaps of skin, extending the incision about 20 cm. upwards and a little down the ellipse—relief incision at middle of the calf; laceration of the sciatic nerve | Healing by first intention. | |
| M | 25 | Jap | Varices | Two sores: (a) on the left lower leg, a chronic, evidently long-existing sore, above the left malleolus internus, tropic disturbances of the skin in the neighborhood of the ulcer; (b) sore at the middle of the left calf. A varicose tumor below the hollow of the left knee | Extirpation of the varicose tumor; after radical cleansing of the sore, a, on and above the left malleolus internus, elliptical excision of the ulcer on the calf, eight stitches in the loosened flaps. This latter ulcer was cured. The other, which could not thus be cured, was cleansed again with sharp spoon and scissors. Laceration of the sciatic nerve | Healing first sore a by second intention. Second sore b by first intention. | |
| W | 20 | J | Varices after pregnancy | At the right outer ankle a sore of the size of half a crown. Varices all over the lower leg, meeting in the hollow of the knee | Resection of the saphenous vein. Radical cleansing of the sore with sharp spoon and scissors. Laceration of the external popliteal nerve | Healing by second intention. | |
| W | 23 | E | Varices after pregnancy | Extensive ulcer on and above left malleolus internus | Portions of the dilated saphenous vein resected. Sore cleansed with sharp spoon and scissors; laceration of the sciatic nerve | Healing by second intention. | |

A PLEA FOR THE IMMEDIATE REDUCTION OF FRACTURES*

BY WILLIAM DARRACH, M.D.

OF NEW YORK

ASSOCIATE ATTENDING SURGEON, PRESBYTERIAN HOSPITAL

"Two weeks ago I fell down and broke my leg. We sent for Dr. Primus who came right away and put it in splints. It hurt a good deal that night and the doctor came the next day to set it, but it had swollen so much he thought it was better to wait until the swelling went down. Two days ago he set it and thought it was all right until he had an X-ray taken yesterday, and now he wants to break it over again."

The frequency with which such a history is encountered is only too great and explains to a large extent the uncomfortable fact that the majority of our fractures to-day have results that are far worse than they deserve to be. The delay in summoning medical aid, which we meet so often in acute abdominal conditions and in cancer, furnishes no excuse in fractures. The laity usually recognizes the injury and the physician is often there within the hour. The time elapsing between the injury and the reduction of the displacement is more apt to be the result of the laziness of the medical attendant or his failure to appreciate the value of prompt action.

It needs but a superficial knowledge of the pathology of repair to realize the importance of early reduction, and its imperative nature becomes more apparent as we study it more deeply. The microscopical examination by Drs. St. John and Whipple of bits of tissue removed at open reduction by the author has been most illuminating. Let us consider what happens in a fracture of the shaft of a long bone, with displacement of the fragments. As the bone breaks and the fragments are driven by one another, the periosteum is torn across on one side and stripped up on the other. There is more or less laceration of overlying muscles, vessels and possibly nerves; there is hemorrhage from the endosteum, the bone ends, the periosteum, both from its torn edges and where it was stripped off the bone; there is hemorrhage into the soft parts, infiltrating along the fascial planes. The distance at which late ecchymoses appear illustrates the extent to which this infiltration occurs. This represents the stage of injury and is almost immediately followed

* Read before the New York Surgical Society, January 26, 1916.

by the earliest stage of repair with the formation of the clot and the further infiltration of the soft parts with serum, giving rise to the swelling and œdema. The formation of a fibrin network or trellis and the appearance of young connective cells advancing into this area is but the question of hours and the rapidity with which the clot may become organized is astonishing. This newly organized tissue fills up the space between the bone ends, the region of stripped-up periosteum, and obliterates the dentations of the fragments so precious to the accurate interlocking of fractured surfaces. The actual deposit of lime salts and the appearance of osteoid tissue may be seen on the third day. This is not the orderly dense bone that shows in an X-ray, but tissue which is dense enough to prevent accurate apposition.

The effect of early reduction of the displacement is twofold; a much more accurate apposition can be obtained and the amount of hemorrhage, and hence the amount of new-formed tissue, will be tremendously decreased. During the first hour after injury, while the adjacent muscles are still soft and free from œdematous infiltration, the ease of reduction is very marked. Much of the pain following fractures is due to the tension of the swollen soft parts and with early reduction this is noticeably diminished. By lessening the amount of necessary repair solid union is greatly hastened. This is all well illustrated in fractures where there is no displacement. There is but little swelling, pain or callus and solid union is rapidly obtained.

The odious dictum, "*wait till the swelling goes down,*" has been the cause of more permanent deformities and more lasting disabilities than its author should care to contemplate. A fracture with displacement should be considered as much of an emergency as an acute appendicitis or a perforated ulcer.

That the reduction can be carried out more efficiently and more gently if the exact nature of the injury is known from the examination of good X-ray plates is without question. And with such evidence at hand much quite unnecessary and harmful manipulation can be avoided in the examination of the injured part. In view of these facts every hospital should have facilities for taking and immediately developing X-ray plates at any hour of the day or night. But if an X-ray plate is not available the reduction should be attempted without waiting for it. The advantages of the early reduction usually outweigh those of the preliminary X-ray.

The question of the best time for an *open reduction* of fractures is quite different. The element of possible infection is here encountered and delay is wise until the body has had a chance to marshal her forces

IMMEDIATE REDUCTION OF FRACTURES

of repair and resistance, and the injured area is entrenched behind the zone of infiltration. The organizing tissue between the fragments can be removed at operation and accurate apposition obtained. Moreover, were early reduction practised generally, the number of open operations required would be almost decimated.

Summary.—Immediate reduction of fractures with displacement results in easier and more accurate apposition, less pain, less swelling, less reparative tissue formation and a more rapid, solid, bony union.

TREATMENT OF INJURIES IN THE VICINITY OF THE ELBOW-JOINT

By H. M. ARMITAGE, M.D.

OF CHESTER, PA.
SURGEON, CHESTER HOSPITAL
AND

GEO. L. ARMITAGE, JR., M.D.

INJURIES in the vicinity of the elbow-joint are frequent and should always be viewed with grave concern from the stand-point of the ultimate result. In the majority of cases good results are obtained under ordinary methods of treatment, but in quite a large number of cases ankylosis is a not uncommon result.

Helferich¹ in 1893 first put arthroplasty upon a rational surgical basis by the interposition of soft parts in a case of temperomaxillary ankylosis. Eight years later Murphy² interposed fascia in a case of ankylosis of the knee-joint. The following year Quenu³ performed the first operation of this character upon the elbow-joint. The magnesium sheets of Pupovac, Gluck's ivory pegs and Baer's⁴ chronicized animal membrane have been abandoned by most surgeons because of unsuccessful results in their hands.

On account of the gratifying results obtained by operative measures in ankylosis, advice is sought in many cases which formerly it was impossible to follow, and we are now in a better position to decide as to the relative merits of the various methods of treatment, each of which has its ardent advocates.

Here as elsewhere in bone surgery, the most important question is—when shall we resort to the open operation? There are certain injuries in which operative measures give the best results and others in which operation is not needed. We shall therefore try to define those cases in which, in our experience, operation is imperative for the best results and those in which it is not; likewise a brief outline will be made of the operations which in our hands have proved most successful.

Just as the question of structure determines to a large extent the presence or absence of movement in joints, so in tracing their development it will be found that the manner of their appearance forecasts their ultimate destination as immovable or movable arrangements.

The elbow in common with all other joints arises in mesodermic tissue which has undergone more or less differentiation. From the out-

INJURIES NEAR ELBOW

set it presents distinct skeletal units from which the special structures of the joint are derived.

The cell mass which constitutes the joint unit presents the appearance of a thick cellular disk, from this mass the investing ligaments, joint cavity and synovial membrane are formed. The synovial membrane is a highly specialized structure whose function it is to secrete a lubricating fluid, and therefore its position is determined by the essential proximity to a direct blood supply.⁵

The elbow-joint provides an instance of a diarthrosis capable of performing the movements of flexion and extension about a single axis placed transversely, *i.e.*, a typical ginglymus diarthrosis or hinge-joint.

The bones which enter into its formation are the humerus, ulna, and radius. The trochlea of the humerus articulates with the greater sigmoid cavity of the ulna, the capitellum of the humerus articulates with the shallow depression or cup on the superior aspect of the head of the radius.⁵

Taken as a whole, the ligaments form a complete capsule which is not defective at any point, although it is not of equal thickness throughout, and certain bands of fibres stand out distinctly because of their greater strength.

The capsular ligament is therefore divided into anterior, posterior, external and internal ligaments. Internal to the capsular ligament there are several pads of fat situated between it and the synovial membrane. Small pads are so placed as to lie immediately in front of the coronoid and supracapitellar fossæ, but a larger one projects toward the olecranon fossæ.

Synovial membrane lines the entire capsule and clothes the pads of fat above referred to, as well as those portions of bone enclosed within the capsule which are not covered by articular cartilage. By its disposition the elbow and the superior radio-ulnar joints possess a common joint cavity. It should be especially noted that the upper part of the neck of the radius is surrounded by this synovial membrane.

The lower extremity of the humerus is furnished with two articular surfaces, the outer of which is a rounded surface called the capitellum, for articulation with the radius, and the inner is a grooved articular surface known as the trochlea, for articulation with the ulna.

The articular surfaces are bounded on each side by the internal and external condyles. Between the internal condyles and the inner lip of the trochlea is the groove for the ulnar nerve. The extensor tendons arise from the external condyle, while the flexor tendons and the pronator radii teres arise from the internal condyle.

On the anterior surface of the bone immediately above the trochlea is a depression, the coronoid fossa, whilst in a corresponding position on the back of the lower end of the shaft there is a hollow space called the olecranon fossa.

The ulna consists of a large superior extremity supporting the olecranon and coronoid processes. The olecranon process lies in line with the shaft. Its posterior surface is smooth and covered by a bursa. Its superior surface receives the insertion of the triceps muscle.

The coronoid process is a bracket-like process which juts forward from the fore and upper part of the shaft. It receives the attachment of the brachialis anticus muscle and to its inner border the flexor sublimis digitorum, the pronator radii teres and flexor longus pollicis muscles find attachment.

In front of the elbow is the termination of the brachial artery with the radial and ulnar branches into which it divides. To the outer side of the main vessel is placed the tendon of the biceps, and to its inner side the median nerve. The ulnar artery leaves the space by passing under cover of the pronator radii teres, the radial artery is continued downward beyond the apex of the space overlapped by the supinator longus. The median nerve disappears between the two heads of the pronator radii teres, and the tendon of the biceps inclines backward between the two bones of the forearm to reach its insertion into the radial tuberosity.

The musculospiral nerve, the anterior branch of the superior profunda artery and the recurrent branch of the radial artery lie deeply in the interval between the supinator longus and the brachialis anticus. Immediately below this point the musculospiral nerve divides into its terminal branches, the radial and posterior interosseous. The anterior branch of the anastomotica magna and the anterior ulnar recurrent artery are placed under cover of the pronator radii teres.

The ulnar nerve enters the forearm between the olecranon and internal condyle of the humerus and then passes between the two heads of the flexor carpi ulnaris. Behind the internal condyle the posterior ulnar recurrent anastomoses with the posterior branch of the anastomotica magna and the inferior profunda.

The posterior branch of the superior profunda and the posterior interosseous recurrent anastomose behind the external condyle.

In the examination of injuries of the elbow-joint we must think of the following possible lesions:

1. Fractures of lower end of the humerus: (a) Supracondyloid fracture (more or less transverse of the shaft above the condyles); (b) T- or V-shaped fractures; (c) epiphysial separation; (d) fractures of the external or internal condyles and epicondyles.

INJURIES NEAR ELBOW

2. Lesions of the radius and ulna: (*a*) Dislocation backward of the radius and ulna; (*b*) fracture of the upper third of the ulna, with or without dislocation forward of the radius; (*c*) dislocation forward of the upper end of the radius; (*d*) fracture of the olecranon process of the ulna; (*e*) fracture of the neck or head of the radius; (*f*) subluxation of the head of the radius; (*g*) fracture of coronoid process of ulna.

3. Simple sprains of the elbow.⁶

Supracondyloid fracture may occur from a fall upon the outstretched hand or a fall upon the elbow. In the first variety we are very apt to have it accompanied by laceration of the brachial artery and by severing or compression of the radial, median and ulnar nerves.

Savarian⁷ reported 4 cases of injury to the nerves. Berard⁸ reported 7 cases. The upper fragment is usually displaced forward so that its sharp end is usually fixed in the skin in front of the elbow, or actually penetrates it.

In the flexion variety the deformity is usually just the opposite, the upper fragment being displaced backward and the lower forward. Usually ether or nitrous oxide is necessary for reduction.

In the extension variety where the upper fragment is displaced forward, draw the forearm and lower fragment downward and forward and push the upper fragment back.

In the flexion variety draw the forearm down and push the lower fragment back and upper fragment forward.

If much swelling is present, evaporating lotions and rest in bed are ordered until the swelling is reduced. The fragments are held in position with an anterior angular splint. While the above method answers nicely in many cases, there are some remaining where reduction cannot be performed, and another class of cases in which there is a compound fracture where the humerus protrudes anteriorly, in which we hesitate to push the infected upper fragment back into the wound.

In the latter class of cases we paint the protruding bone with tincture of iodine, put on an aseptic dressing, and put the patient to bed for a week.

If no infection has occurred, then try to reduce. If infection has occurred, open up as much as necessary for drainage and wait.

Very often when the time arrives for attempting reduction the fragment will not go back, and in these cases we should operate.

Make either an external lateral or posterior incision. The posterior is the most generally accepted, but we prefer the lateral, although as a matter of fact it makes very little difference which one is used, both have their advantages.

If the external is decided upon, make the incision upon the outside of the arm, avoiding the musculospiral, radial, and posterior interosseous nerves.

To map out the course of the musculospiral nerve, first mark the point where it pierces the external intermuscular septum, viz.: the junction of the upper and middle thirds of a line extending from the insertion of the deltoid to the external condyle, from this point draw a line obliquely downward and forward to the front of the external condyle where the nerve divides into its radial and posterior interosseous branches.

It is rather surprising to one unaccustomed to use this incision, how far forward the nerve lies. After the incision is made, work in and around the lower end of the humerus with the finger, free it and cut off enough to allow full flexion of the arm. Dress in extension for several days until the pain and swelling subside, and then in the Jones position. Begin passive motion at the end of three weeks.

Intercondyloid, T- or V-fractures are usually due to direct force applied posteriorly. If the intercondyloid fracture is a mere fissure, the displacement is like that of an ordinary supracondyloid fracture and the treatment described for it applies here. If there is a marked displacement of the condyles and they are crushed into many fragments the treatment outlined for fractures of the condyles applies.

Up to the eighteenth year when there is a fracture in the neighborhood of the elbow-joint, the chances of its being epiphysial are about 25 per cent. The lower epiphysis of the humerus develops from four centres of ossification. That of the capitellum appears in the third year; the internal epicondyle in the fifth year. The centres in the trochlea and external epicondyle appear in the eighth year.

After the eighth year a displacement of the capitellum and external epicondyle may occur together. After the thirteenth year there are only possible epiphysial separation of the three coalesced nuclei (external epicondyle, capitellum and trochlea) and the internal epicondyle. From the sixteenth or seventeenth year and up to the eighteenth or nineteenth year only epiphysial separation of the internal epicondyle is possible because the internal epicondyle does not unite until the seventeenth year.

The lower fragment is usually displaced backward, as in supracondyloid fractures. The treatment is rest in bed with the arm in extension for a week and then the arm is placed in the Jones position. Motion is begun at the end of the third week.

Fractures of the external condyle run into the joint and the capitell-

lum is usually broken off. This injury occurs most frequently in children. The treatment consists in extension in bed for a week and then dress in Jones position.

This applies to the ordinary case without much displacement, but in some cases the condyle is displaced so that it is wedged in front of the joint and very little or no motion is possible. The musculospiral nerve or its branches are not infrequently torn or compressed.

In these cases, without injury to the nerves, we should give an anæsthetic and try to reduce the fragment. If reduction is impossible, operate. Make an external incision avoiding the musculospiral, radial and posterior interosseous nerves, dissect the muscles apart and remove the fragment. Unite the supinator longus and extensor carpi radialis longior to the triceps with two or three catgut stitches; in this manner the lower end of the humerus is covered.

We are aware of the fact that we are not following the generally accepted principle in this operation. Most authorities believe that the condyles should be fastened in place and not removed. It has been our experience to find partial ankylosis after this method of treatment, probably because motion has not been started early enough for fear of displacing the condyle. When the condyle has been removed, we put the arm up in the flexed position at the end of a week and begin motion at the end of the third week. The arm has not been weakened perceptibly and excellent results have followed this plan of treatment.

If the musculospiral is torn the symptoms will evidence themselves by lack of use of the extensors and supinators. If the tear is recent, sew the divided ends together; if old and bound down in cicatricial tissue, release it and make a new bed in muscle for it. The nerve may appear normal, its lack of functioning being due to a kind of stupor. It is claimed that the injection of 1 or 2 c.c. of a 1 per cent. solution of methylene blue will arouse it to normal functioning.⁹

The outer epicondyle is never fractured alone. The inner epicondyle is an epiphysis and not infrequently breaks from muscular action or direct violence. There is very little displacement. They should be treated in extension until the end of the first week. Passive motion should be started at the end of the third week and persisted in until full range of motion is acquired.

The line of fracture runs into the joint in fracture of the internal condyle. In the ordinary case, rest in bed with the arm in extension one week and then in Jones position with passive motion at the end of the third week applies to this injury, but in the cases where the inner condyle is so displaced that the arm cannot be flexed operative interference is justified.

An internal incision is made avoiding the ulnar nerve, which lies in the interval between the internal condyle and olecranon. The nerve should be picked out of the groove and retracted inwardly, the condyle should then be removed. The carrying function of the arm will be lost by removing the internal condyle, but since we only operate in those cases where the condyle is displaced enough to interfere with the motion of the joint, we have followed the plan of removal rather than fixation.

If the ulnar nerve has been injured as evidenced by partial paralysis of the flexor profundis digitorum, total paralysis of the flexor carpi ulnaris and loss of sensation in little finger and half of ring finger, it should be sutured with chromic gut, freed from all adhesions and covered with muscles.

Dislocation backward of the radius and ulna can almost always be reduced by administering an anæsthetic and hyperextending the forearm while it is supinated, the arm itself being steadied by the hands of an assistant. Moderate traction then draws the forearm gently forward while the other hand seizes the elbow and controls the position of the parts.

The arm should be maintained in a flexed position upon a posterior moulded or metal splint. Light passive motion is begun during the third week. Lateral dislocation of both bones of the forearm is very rare and is reduced by traction on the forearm in the hyperextended position followed by flexion and pressure exerted in an inward or outward direction as the case may be.

Forward dislocation of both bones of the forearm is also very rare. Reduction is effected by pressing or pulling the upper end of the forearm downward or backward.

Divergent dislocation of the bones of the forearm is rare and is reduced by direct pressure over the radius and hyperextension of the ulna.

The same treatment applies to dislocation of the radius or ulna alone. In fracture of the upper third of the ulna without dislocation of the radius, the deformity is reduced, using an anæsthetic if necessary.

The anterior and posterior wooden splints or moulded plaster-of-Paris splints are the most frequently employed. A circular plaster cast may be applied in cases where there is danger of moving the fragments, after the swelling subsides.

Where dislocation forward of the radius is present in addition to fracture of the upper third of the ulna, an attempt should be made to reduce it by direct pressure. It may be impossible to reduce it or the

INJURIES NEAR ELBOW

head of the radius may project through the skin ; in the latter case, paint with iodine and dress, but do not attempt to reduce. In the former case an arthrotomy may be possible, but where the head projects through the skin it will usually be necessary to resort to resection.

The incision is a posterior one about three inches in length made between the anconeus and extensor carpi radialis. The head of the radius is exposed. If the capsule is interposed, preventing reduction, remove it, reduce the dislocation, suture the capsule if possible and bring the soft parts into apposition about the head of the radius with a few catgut sutures. If a resection is necessary, which is usually the case in an old unreduced dislocation, in one where the head projects through the skin or a case where the bone is separated from the shaft, simply remove the head above the insertion of the biceps. Put in a few deep sutures. Close the skin. Dress in extension for about five days and then dress in a sling. Begin motion in a week. Dislocation forward of the upper end of the radius, independent of fracture of the ulna, and fracture of the neck or head of the radius are both treated according to the plan just outlined.

The non-operative treatment of fractures of the olecranon process of the ulna consists in treating the arm in extension with a well padded anterior splint of plaster of Paris, metal or wood extending from the level of the axilla to the finger tips. The danger of ankylosis is great after this fracture. The patient should be kept in bed for ten days. The anterior splint should be used for four weeks, once a week it should be removed, the elbow massaged and the splints reapplied. Passive motion should be very cautiously used at the end of the fourth week.

The best results in this fracture will be secured by treating all cases with extra-articular operation.

Murphy's operation is as follows: A longitudinal incision one-third inch long on the outer side of the ulna down to the bone ; one-half inch from the articular surface make a corresponding incision on the inner side. The ulna is perforated between these two cuts with a drill ; pull a wire or kangaroo tendon through the drill hole. The wire is carried upward under the skin on the inner side of the elbow to the tip of the olecranon. The wire or suture is then passed through the upper puncture transversely through the triceps tendons and emerges on the outer side. The wire is once more reintroduced and emerges at the original incision. The site of fracture is now encircled with wire or suture. Tighten and twist if wire, cut the ends and bury the knot.

The arm is immobilized for four weeks in the extended position, with passive motion on the third day.

Subluxation of the head of the radius is reduced by direct pressure. If irreducible it is treated like a dislocation forward of the end of the radius.

Fractures of the coronoid process are rarely observed. The treatment is by an anterior splint, the angle of which is less than a right angle. Jones' position may be used in treating such a case.

Simple sprains of the elbow are treated as sprains elsewhere, by rest and evaporating lotions.

In conclusion it should be said that bandages and splints are largely responsible for the stiffness following upon joint injuries, and that the best results are observed by dressing in acute flexion as soon as the acute symptoms have subsided, during which time they are dressed in extension.

The arm is dressed in flexion by fastening a bandage around the wrist and neck, first feeling to see if the radial pulse is perceptible.

Ankylosis, partial or complete, may result from prolonged immobilization, the muscles contracting and becoming fibrous, the fascia and ligaments about the joint shortening, the capsule shrinking and thickening, some of the cartilages becoming fibrous and the joint being partly obliterated. It may result from extravasation of blood into the joint and tendon sheaths with subsequent formation of fibrous tissue. It may arise from organization of inflammatory exudate within and about the joint and in the sheaths of muscles and tendons.

The best method for preventing ankylosis due to the above causes is passive motion. Many able authorities teach that motion should not be persisted in beyond the point of pain, but we have found that the point at which pain is first observed is difficult to determine, especially in children, and our method is to move slightly during the third week, a little more during the fourth week and during the fifth week get full motion as nearly as possible, whether it causes pain or not.

Passive and active motion are used until we are convinced that we have secured as wide a range of motion as possible, and this period of treatment generally extends over many months.

Ankylosis may arise from the formation of callus or displaced fragments. Bruns claims that in fracture into the joint excess of callus rarely forms and that masses of callus form chiefly in the line of fracture near but not in a joint.

Formation of excessive callus and fragments displaced so as to interfere with the motion of the joint demand operation, and to experiment with different methods of massage, splints and positions are derogatory to our judgment and hazardous in the extreme to the welfare of the



FIG. 1.—Case I. Firmly ankylosed joint two months after injury. Shows extent of flexion before operation. Paralysis of supinators and extensors existed, due to rupture of the posterior interosseous nerve.



FIG. 2.—Case I. Extent of flexion after operation, also full power in supinators and extensors following suturing of posterior interosseous nerve.



FIG. 3 —Case I. Shows lateral dislocation of both bones of forearm and fracture of the external condyle.



FIG. 4—Case II. Arm in extension, two months after operation.



FIG. 5—Case II. Extent of flexion, two months after operation.



FIG. 6—Case II. Shows supracondylar fracture of the humerus. The lower end of the humerus projected through the skin.



FIG 7.—Case III. Extent of flexion three months after injury.



FIG 9.—Case IV. Fracture of internal condyle of humerus. Shows flexion three months after injury.



FIG 8.—Case III. Fracture of internal condyle

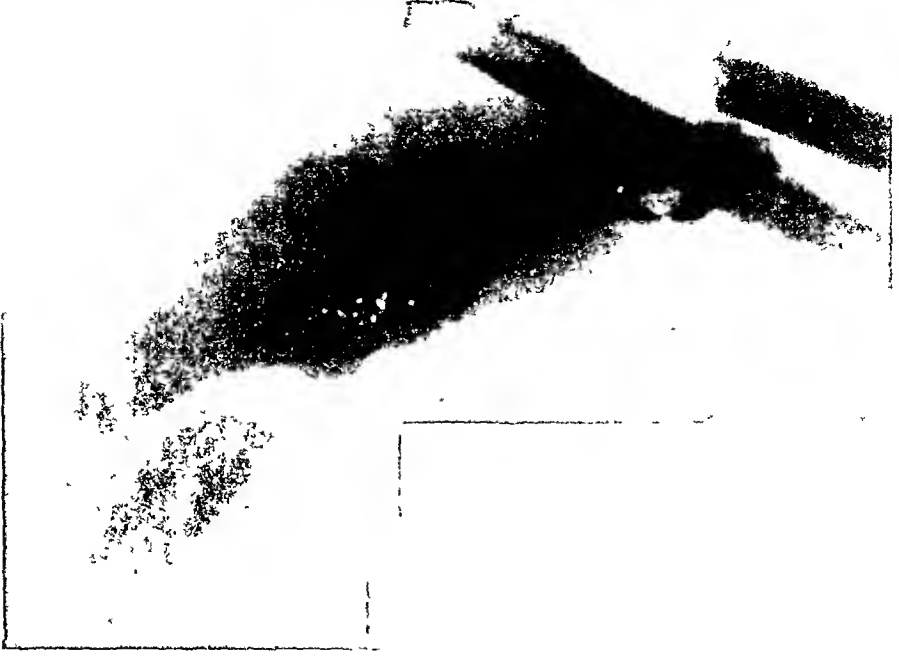


FIG. 10.—Case V. Fracture of lower third of humerus and upper third of ulna, with dislocation of radius, the end of the radius projecting through the skin. Arthroplasty with interposition of fascia was finally necessary. Result was a fairly useful arm.



FIG. 11.—Case VI. Posterior dislocation of both bones of the forearm. Reduced under nitrous oxide.

INJURIES NEAR ELBOW

patient, since the result will be an ankylosed joint requiring a formal arthroplasty for correction.

NOTE.—We wish to acknowledge our indebtedness to Dr. W. E. Egbert for the X-ray plates and photographs.

REFERENCES

- ¹ Helferich: *Verhandl. deutsch Ges. f. Chir.*, 1894, xxiii, 504.
- ² Murphy, N.: *Tr. Am. Surg. Assn.*, 1904, xxii, 313.
- ³ Quenu: *Bull. et mem. Soc. de Chir. de Paris*, 1902, xxviii, 124.
- ⁴ Baer: *Am. Jour. Orthop. Surg.*, 1909-1910, vii.
- ⁵ Cunningham's *Anatomy*.
- ⁶ Keen's *Surgery*, vol. ii, 181.
- ⁷ Savarian: *Arch. gén. de Méd.*, 1903.
- ⁸ Berard: *Lyon Médicale*, 1904.
- ⁹ Sicard, J. A.: *Presse médicale*, February 25, 1915, xxiii, No. 8.

FRACTURE-DISLOCATION OF THE ASTRAGALUS

TREATMENT BY REDUCTION THROUGH OPEN INCISION

BY ERNEST F. ROBINSON, M.D.

OF KANSAS CITY, MO.

EXCISION of the displaced astragalus, whether in part or whole, in cases of fracture-dislocation of that bone has invariably resulted in a flat, distorted and impaired ankle-joint. From the very mechanism of the ankle this cannot be otherwise. The keystone of the arch of the joint has been destroyed or its form altered, and the recipient of such an injury is rendered, to a greater or lesser degree, a permanent cripple. My own experience with this injury had been so unsatisfactory that when the case herein reported presented itself with a fracture and posterior displacement of the astragalus, I decided, despite the weight of opinion to the contrary, to attempt "open reduction," although the fragment of the astragalus was loose and seemed devoid of blood supply. A curved incision was made on the outer side of the ankle and with the aid of a "jimmy" or long periosteal elevator, one surface of which was roughened, the loose displaced body of the astragalus was replaced. Aided by traction made by an assistant on the foot, I found, to my surprise, this was accomplished with but little difficulty, although it had been absolutely impossible by traction and manipulation alone before the ankle-joint was opened. The result as herein shown by the X-ray pictures was so anatomically accurate and the restoration of function so complete that I have felt the case worthy of record.

J. R., machinist, forty-eight years old; General Hospital, admitted November 1, 1913. Diagnosis, fracture of astragalus. The day previous he fell from a ladder, landing on his right foot, between two steel rails. The ankle-joint was forcibly bent forward, the toes coming almost in contact with the anterior surface of the tibia. The astragalus was broken off at the neck and the body of it displaced backward and outward, where it could be felt resting on the os calcis (Fig. 1). The ankle was enormously swollen. Several large blebs developed. Attempts at reduction under a general anæsthetic failed. A temporary dressing was applied. On the seventh day after the accident he was again given a general anæsthetic but reduction was impossible. A four-inch curved incision was made on the outer surface of the ankle. The loose displaced body of the astragalus was brought into position



FIG. 1.—Posterior fracture-dislocation of astragalus.



FIG. 2.—Posterior fracture-dislocation of astragalus after operation for reduction.

FRACTURE-DISLOCATION OF THE ASTRAGALUS

(Fig. 2) with the aid of traction and a large periosteal elevator, one side of which was rough. This was used as a "jimmy" and was of such service that the reduction was not especially difficult. The wound was closed without drainage and a plaster case applied. The patient left the hospital December 22, 1913, with a freely movable ankle.

Although fracture-dislocation of the astragalus is not common, yet within the past two years I have encountered five such injuries. Of these, three were posterior and two were anterior dislocations, one of the latter also being compound. Excision was performed in three cases with considerable degree of impairment of function in all of them. The compound anterior dislocation became infected and ankylosis, almost complete, resulted. The case in which operative reduction was accomplished resulted in entire restoration of function.

The mechanism by which this fracture is produced is of considerable interest. The patient falls usually from a height, lighting with the foot either completely flexed or extended. The articulating edge of the tibia acts as a wedge, cutting or crushing through the astragalus at its neck. Very rarely the whole bone may be dislocated. This is usually attended by a chipping off or fracture of a portion of the articulating surface of the tibia. If reduction can be accomplished without incision, operation, of course, is unnecessary, but in my experience accurate anatomical restoration is impossible unless the joint is opened. Strict asepsis and the avoidance of unnecessary trauma are essential. The open wound is closed without drainage. A plaster cast is worn for several weeks. Its removal at intervals for manipulation and massage after the first two weeks materially aids in preventing ankylosis.

A SIMPLIFIED PRE-OPERATIVE TREATMENT OF THE HANDS AND FIELD OF OPERATION*

BY A. D. WHITING, M.D.

AND

MORRIS A. SLOCUM, M.D.

OF PHILADELPHIA, PA.

A GERM-FREE condition of the skin is not essential to the perfect healing of surgical wounds. The approach to sterility obtained by the various methods and agents that have been advocated from time to time is sufficient to afford rapid healing in a vast majority of cases. Many of the methods, however, are complicated and require considerable time for their execution; some of the agents are applicable to the field of operation alone, and only under certain conditions of the skin; some of them have deleterious effects upon the tissues.

The ideal method would be simple in application, efficient in action, free from deleterious effects, applicable to the wet or dry skin and to the hands as well as to the field of operation, and allow of rapid execution. To be efficient in action the agents used should dissolve or penetrate the débris composed of the secretions and excretions of the glands of the skin, countless broken-down cells and mechanical dirt which surround bacteria on the surface and in the most superficial layers of the skin; they should decompose and remove small particles of air that may be present in the cracks and crevices of the skin and thus penetrate more deeply; they should destroy all germ life with which they come in contact in a short space of time. To be free from deleterious effects, the methods and agents should not be harmful to the tissues, and above all should not interfere with their natural resistive and recuperative powers.

The approach to the ideal in methods or agents must be proved by both clinical and laboratory findings. The clinical results may be judged by the presence or absence of rapid and aseptic healing of the wounds, although it must be remembered that healing by first intention does not prove the absence of germ life. It simply shows that there is sufficient resistance in the tissues to overcome the activity of any bacteria that may be present. Probably the surest, the most positive prophylaxis against wound infection is conservation of the natural resistive and recuperative powers of the tissues.

* Read before the Philadelphia Academy of Surgery, December 6, 1915.

PRE-OPERATIVE TREATMENT OF THE HANDS

The laboratory should prove the value of the agents in destroying bacteria, preferably according to the Rideal-Walker coefficient test, which takes carbolic acid or phenol as a standard and compares the efficiency of other agents with phenol in the ability to destroy the *B. typhosus*. The value of the agent as a germicide "can be expressed by a number called its coefficient which indicates how many times more, or in some cases less, the disinfectant can be diluted than phenol and retain an equal germicidal value." The laboratory should also show the value of the method and agents in either destroying all bacteria in the skin or in reducing them to a minimum, which may be shown, approximately, by imbedding scrapings from the skin in culture media and properly incubating them. We believe that the scraping instrument itself should be imbedded in the medium and that the method of testing which simply rinses the scraping instrument in the medium is faulty and unreliable. To obtain our scrapings both of the hands and the field of operation, we used a roughened strip of mother-of-pearl, this being used because it is readily sterilized in the autoclave, because it can be used repeatedly and because it can be imbedded in the culture medium. To avoid wrong conclusions, all chemical agents used must be neutralized or removed from the skin before the scrapings are taken, because an almost infinitesimal quantity of many antiseptics will be sufficient to prevent the development of bacteria. Scrapings should be taken thirty minutes after the supposed sterilization of the skin to prove that active bacteria have not been thrown onto the surface from the deeper layers of the epidermis. As demonstrated by Leedom-Greene and others, the skin must be moist when the scrapings are taken, because, in a dry condition, the cement substance of the epidermis holds the cells and bacteria in place to a much greater extent than it does when moist. A vigorous 24-hour culture of some easily recognized organism should be rubbed thoroughly into the skin and scrapings should be taken before and after the application of the agents being tested. Finally, a piece of the skin itself should be imbedded in culture medium and incubated for at least 48 hours.

In a former paper ("The local preparation of patients for operation," by A. D. Whiting, M.D., *J.A.M.A.*, August 8, 1914, vol. lxiii, p. 474) one of us reported several series of tests made to show the value of various methods and agents used in attempts to render the skin free from germ-life. These covered the dry method of sterilization; the wet method with the use of different chemical solutions; the combination of the wet and dry methods; and the method of freeing the skin of all bacteria by sweating. Those investigations seemed to

show that the skin could be made sterile by washing it from within outward by stimulating its natural activity, but that no other method of mechanical or chemical cleansing would render it sterile.

After studying an article by Hamilton (*American Journal of Pharmacy*, July, 1915) which grouped the various coal-tar disinfectants, and another by McDonald (*Surg. Gyn. and Obs.*, July, 1915) which suggested the use of acetone as a solvent and alcohol as a vehicle with the incorporation into an acetone-alcohol solution of a germicide, we have experimented with several solutions in an endeavor to find one that would approach the ideal, or at least would more nearly sterilize the skin than the various methods and agents that one of us had previously investigated, be more simple in application, and allow of more rapid execution.

Hamilton states that since 1889 when the composition of creolin was made known to the scientific world, hundreds of the coal-tar disinfectants composed of creosote oil and soap and containing various proportions of the phenols have been exploited. These phenols are so called because they resemble carbolic acid or true phenol, in composition and action. They differ from carbolic, however, in being but slightly soluble in water, in being less corrosive and less poisonous, and in having greater germicidal power. They differ among themselves according to the coal-tar oil used in their manufacture and the different treatment to which they are subjected to make them soluble in water. Hamilton divides these disinfectants into three groups, according to their efficiency, the third group containing those of a high phenol coefficient. Unfortunately, many of these disinfectants, and especially those of Group 3, are proprietary preparations, the manufacturers keeping secret, for trade purposes, their method of manufacture and treatment, although making strong appeals for the use of a particular one in preference to all others. None of the preparations we have tested, according to our findings, has lived up to the reputation given to it by its proprietor. We wish to make it emphatic that we hold no brief for any manufacturer and that our sole object in mentioning any proprietary preparation is to stimulate interest in the surgical use of coal-tar disinfectants of a high coefficient in the hope that the proper authorities will provide the profession with at least one that is strictly ethical.

The following scheme of investigation was carried out at the German Hospital, service of Dr. Deaver, to whom we are indebted for the free use of surgical material.

Field of Operation.—When not contra-indicated, the field of opera-

PRE-OPERATIVE TREATMENT OF THE HANDS

tion was wet-shaved and the patient was given a warm tub bath the night before operation. During the day of operation, without further preparation, the field of operation was scraped with the mother-of-pearl strips, which were placed in bouillon and in liquefied agar which was plated. All culture tubes and Petri dishes were incubated at 37° C. for 48 hours.

Results.—All cultures showed a growth of staphylococci.

The field of operation was then surrounded by sterile sheets or towels and the part was rubbed for two minutes with gauze saturated with the solution being tested. The field was then washed off with sterile water or the solution was allowed to evaporate and scrapings were again taken with the pearl strips.

Result.—All cultures remained sterile.

A sterile dressing was then placed over the field and held in place by a sterile bandage. Thirty minutes later, the dressing was removed under aseptic precautions, the skin was moistened with sterile water and scrapings were again obtained with the pearl strips. These scrapings were taken to show whether or not bacteria had been brought to the surface of the skin from the deeper layers through the natural activity of the skin.

Results.—A total number of 446 of these various scrapings were obtained. With the exception of 38, all were returned sterile. Of the 38, one tube showed the presence of staphylococcus and 37 showed contamination. In the series of tests previously reported by one of us, but 2 out of 86 such scrapings remained sterile.

After the completion of an operation on a clean case, a small strip of the skin, including all layers, was removed just before the wound was closed, placed in bouillon and incubated at 37° C. for 72 hours.

Results.—Strips of skin from 117 patients cultured. Returned with no growth, 34; returned with growth, 83. Of the 83, 3 showed staphylococci, 1 streptococci, 58 large Gram positive cocci, 6 small Gram positive and negative cocci, 7 small Gram negative bacilli, 6 small positive and negative diplococci, and 2 sporulating bacteria. The laboratory reported that the majority of the growths were caused by contamination by non-pathogenic bacteria. The wounds of all but three of these cases healed aseptically. Of these three two were cases of acute appendicitis with some exudate and one was a myoma of the uterus in a patient with a very fat abdominal wall.

The Hands.—The hands and forearms were scrubbed with soap and hot running water, a bristle brush being used. The hands and forearms were then washed with the solution under consideration for

two minutes, a piece of sterile gauze being used to rub the skin. The hands were then thoroughly rinsed with sterile water and scrapings were taken with the pearl strip, the person being tested handling the strip himself, rolling it in the hands, scraping the skin, the nail-grooves and the under-surface of the free margin of the nails. The strips were imbedded in bouillon and incubated at 37° C. for hours.

Results.—All cultures were returned with no growth.

The hands were then incased in impervious, sterile rubber gloves. After the completion of an operation, the gloves were removed and similar scrapings were taken. The hands were again washed with soap and water, immersed in the solution, and again incased in rubber gloves. After each operation, scrapings were taken as before.

Results.—One hundred and forty-five scrapings were obtained, 96 were returned without growth, and 49 with growth. Of the 49, 5 showed staphylococci, in 3 and 2 successive cultures on different days. The laboratory reported that the growth in the other 44 cultures was due to contamination by non-pathogenic bacteria.

The hands were washed with soap and water for two minutes. Then 10 c.c. of a 24-hour culture of staphylococcus albus was thoroughly rubbed into the hands and allowed to dry. Scrapings were taken with the pearl strips and imbedded in bouillon and in liquefied agar which was plated.

Results.—All scrapings gave an abundant growth of the staphylococcus.

The hands were then treated with the solution under consideration, the solution was washed off with sterile water and scrapings were again taken and cultured.

Results.—Culture of sterile water before being used to remove solution, sterile. All culture of scrapings returned with no growth. Sterile water used in washing off the solution cultured and returned with no growth.

Same procedure on a different day, with immersion in the solution for 30 seconds, one minute, one and a half minutes, and two minutes. All cultures of scrapings returned with a growth of large Gram positive cocci, which the laboratory stated were positively not staphylococci.

Same tests repeated on third day, with same solution and technic throughout. All cultures returned with no growth.

Laboratory tests were made to show the germicidal properties of various agents and various solutions of them. This entailed an enormous amount of work and we wish to express our gratitude to Dr. Damon B. Pfeiffer, the Chief of the Laboratory, and to Dr. Carl

PRE-OPERATIVE TREATMENT OF THE HANDS

Becker, who so willingly and carefully made all of the laboratory tests for us. There were made 1174 cultures of the typhoid bacillus which had been subjected to the action of different strengths of 23 different agents or solutions for varying lengths of time. All were properly labelled and incubated at 37° C. for 48 or 72 hours.

Results.—Acetone has no germicidal power.

Alcohol in strengths varying from 40 per cent. to 95 per cent. destroyed the *B. typhosus* in less than 2½ minutes.

Acetone 40 parts and alcohol 60 parts destroyed the *B. typhosus* in less than 2½ minutes.

Acetone 40, alcohol 60, and liq. cresolis comp. 2 parts gave the same results.

Acetone 30, alcohol 65, liq. cresolis comp. 5 parts; acetone 40, alcohol 60, and crude carbolic acid 2 parts; acetone 40, alcohol 60, and pyxol 2 parts; acetone 35, alcohol 60, and creolin 5 parts; acetone 35, alcohol 63, and phenoco 2 parts, all destroyed the *B. typhosus* in less than 2½ minutes.

Liq. cresolis comp. gave a phenol coefficient of 2; creolin 1.5; pyxol, a proprietary disinfectant which the manufacturers claim to have a coefficient of 20, has a coefficient of 4, according to our laboratory reports.

Phenoco, another proprietary disinfectant with the manufacturer's claim of a coefficient of 15, has a coefficient of 9 according to our laboratory reports. Phenoco has been placed in New and Non-official Remedies, 1915, by the Council of Pharmacy of the American Medical Association.

As a result of these investigations, we would conclude that none of the various solutions used will destroy all germs of the skin in all instances, but that a solution consisting of acetone, alcohol, and one of the coal-tar disinfectants of a high phenol coefficient is more efficient than any other agent we have ever used for skin sterilization. In such a solution, the acetone (dimethylketone) acts as a solvent of the fatty or oily material of the skin and thus aids in exposing the bacteria to the germicides. The alcohol acts as a solvent; it has the power to penetrate into the cracks and crevices of the skin, as claimed by Braatz, through its ability to decompose and remove small particles of air that may be present; it is germicidal in solutions as weak as 30 per cent., according to Post and Nicoll, in solutions ranging from 40 per cent. to 95 per cent., according to our findings, with its strongest germicidal powers in solutions ranging from 60 per cent. to 70 per cent., according to Leedom-Greene; it also acts as a good vehicle. The coal-tar disin-

fectant that may be used acts simply as a powerful germicide, destroying all bacteria with which it comes in contact in a length of time varying with its coefficient and the degree of dilution.

The advantages of such a solution are many. Patients do not complain of any irritation following its use, although it causes a burning sensation when used on the scrotum. It does not stain the skin. It reduces to a minimum the time consumed in preparing the field of operation, and its method of application is the simplest. It may be used on a wet or dry skin, for emergencies or for cases where the consumption of time in preparing the patient is not of great moment. There is no exfoliation of the skin as is seen after the use of iodine, nor is there any blistering. It may replace all other solutions in sterilizing the hands, although its continuous use causes some irritation in some instances; in others, no effect is noticed; others say the application of the solution gives rise to a decided feeling of warmth. The solution may be used repeatedly, any collected detritus being removed by filtration.

To further hospital efficiency, to save time, to remove the danger of faulty technic in complicated methods, and to save expense, we would suggest that a solution consisting of 35 per cent. acetone, 1 or 2 per cent. of a coal-tar disinfectant of a high coefficient, preferably phenoco, with enough alcohol to make 100 per cent., would answer the purpose. The method of application consists in rubbing the field of operation for two minutes with a piece of gauze saturated with the solution after either a wet or dry shave. A warm. cleansing tub bath is, of course, always advisable when not contraindicated.

DOUBLE UTERUS AND VAGINA WITH A NEW BLOODLESS OPERATION FOR THE CORRECTION OF THE DEFORMITY*

BY A. E. ROCKEY, M.D.

OF PORTLAND, OREGON

Two cases of this malformation have come under my personal observation. Beyond the vague statement by several text-book authors that it is fairly common, my library contains no statistics of its relative frequency. The index of the first sixty volumes of the *ANNALS OF SURGERY* makes no mention of it. In Ashhurst's *System of Surgery*, in the gynæcological section, written more than thirty years ago, by Theophilus Parvin, of Philadelphia, there is a rather comprehensive paragraph with eight quotations from the literature. Since that time but little has been added, except an illustration of a case in Kelly's *Operative Gynæcology*, published in 1898, Fig. 1, and one by Dr. J. M. Fisher in Volume V of Keen's *Surgery*. One modern encyclopædic work treats the subject, including operative method, in a five-line paragraph. If the condition is fairly common, it must be that at the present time it is not considered of sufficient importance to gain any prominent notice.

Embryologically this malformation is an arrest of development rather than a redundancy, as the duplicity of parts would suggest. The uterus and vagina are developed from the fusion of the Muellerian ducts, which occurs between the tenth and twelfth week of fetal life. Normally the intervening septum is absorbed, and a single cavity and canal results. Arrest of development in this fusion causes uterus bicornis, septus, or subseptus, which may occur either with or without the persistence of a partial or complete septum in the vagina. When the vaginal septum is obliterated within the hymen, or when one vaginal canal remains rudimentary, the condition may be undiscovered until a bicornate uterus is found during the performance of an abdominal operation. When it is complete it may not be found until labor occurs, or, if the vaginæ are rather small, may be discovered after marriage.

The operative procedures mentioned in the literature are limited to the division of the vaginal septum. Excision with scissors and suture of bleeding points is the method suggested, though Parvin also mentions

* Read before the North Pacific Surgical Association, Spokane, December 17, 1915.

the elastic ligature, and galvanocautery loop. I find no suggestion for the removal of the uterine septum.

Of the two cases that I have observed, one was in a woman forty years of age. The vaginal septum had been excised after marriage, years before, and was evident only as a slight ridge, and an interruption of the normal vaginal rugæ in the middle line. There was a double cervix with a complete septum in the uterus. She had never conceived.

The case which I wish to report in detail was referred to me by Dr. A. Tilzer:

Patient was married at the age of nineteen and a half years, in April, 1906. Seven weeks later she consulted Dr. Tilzer, who

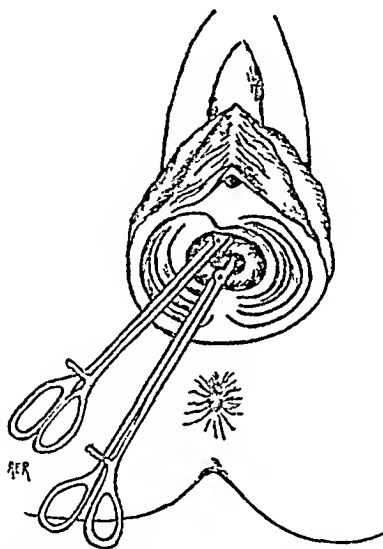


FIG. 2.—Showing forceps placed on septum, and the septum divided between the forceps with scissors.

discovered that she had a double vagina and double uterus. On May 15, 1906, the operation, which I will describe below, was performed. In November, 1908, she was delivered of a normal girl baby; also in July, 1910, of a normal girl baby; on April 24, 1912, a girl baby, breech presentation; on September 9, 1913, a boy. The children were all normal, and living.

The following operative procedure was adopted in this case. Under ether anæsthesia a long straight broad ligament clamp was placed on the posterior part of the vaginal septum, and another on the anterior part (Fig. 2). The ends of both extended to the vaults of the vagina. They were firmly clamped, and the septum divided between them with scissors. Two long, straight, right angle retractors were introduced through this incision between

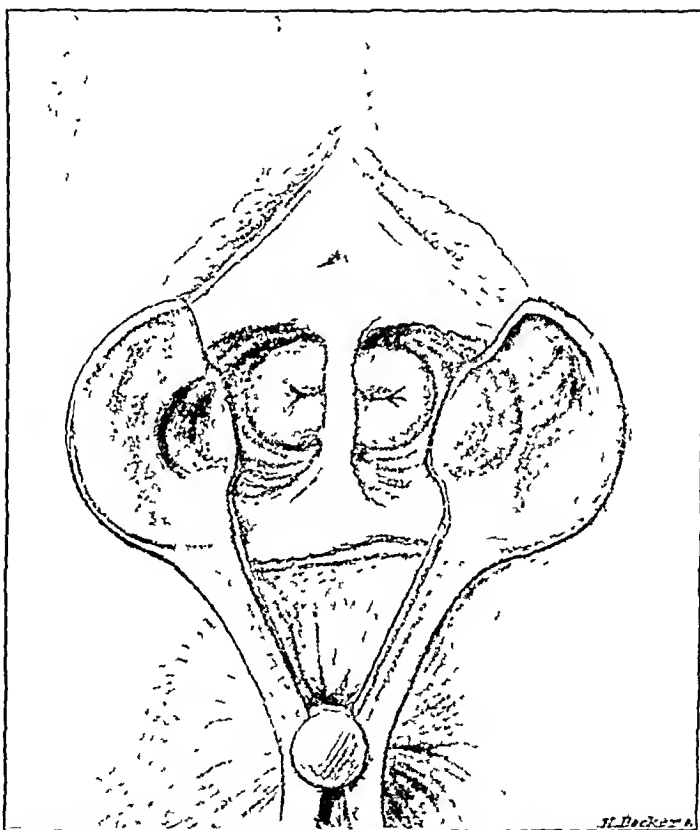


FIG. 1.—Double vagina and double cervix, with a blade of a bivalve speculum introduced into each side so as to show both cervices and the septum in the middle. (From Kelly's *Operative Gynæcology*, p. 241, vol. i.)

DOUBLE UTERUS AND VAGINA

the clamps and the now enlarged vagina, permitting a good view of the double cervix. Exploration by two uterine sounds demonstrated the presence of a complete septum in the uterus. The

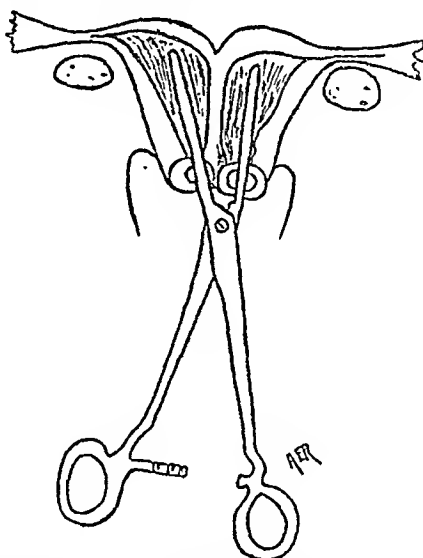


FIG. 3.—Showing one blade of forceps on each side of double uterus, preparatory to destroying the septum by pressure necrosis of the clamp.

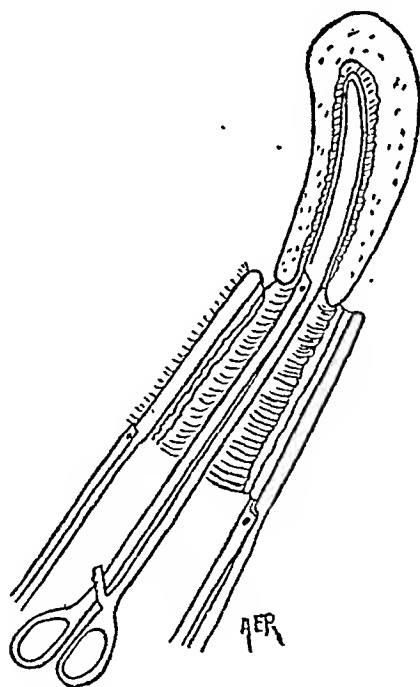


FIG. 4.—Side view of forceps on divided vaginal septum and central clamp fastened to uterine septum.

cervices were separately dilated with a small uterine dilator. This permitted the introduction across the septum of the blades of a full length curved clamp forceps (Fig. 4). This was then firmly

locked into place, compressing the septum (Fig. 3). The handle of this forceps was supported by a folded strip of gauze placed under it in the vagina, and over the perineum, to avoid pressure injury by its weight. In bed the handles of all three forceps were further supported by pads. They were allowed to remain in place for thirty-six hours, and were then removed. The compressed septum soon sloughed out, and healed completely, leaving a single uterus and vagina, that were normal in appearance.

The simultaneous examination of the cavities with two sounds during the performance of this operation is important. The existence of a possible bicornate uterus with a wide low divergence of the bodies should be predetermined. In such a case it might be advisable, after introducing the separate blades of the long curved clamp into the cavities (Fig. 4), to raise the table to the Trendelenburg position, and close the clamp very slowly to avoid any possible injury by catching the intestine between the approximated uterine bodies. In uterus septus, or when, as is usually the case, only the upper part of the body externally is bicornate, no such possibility exists.

By this method the fusion of the two vaginal canals and the two uterine cavities, by forceps pressure, is accomplished with facility and without any bleeding.

INDEX OF TOXICITY OF NOVOCAINE-ADRENALIN INJECTED INTRAVENOUSLY

BY JOSEPH RILUS EASTMAN, M.D., BERNHARD ERDMAN, M.D.

AND

HARRY K. BONN, M.D.

OF INDIANAPOLIS, INDIANA

THE use of novocaine-adrenalin in regional anæsthesia is steadily assuming greater clinical importance. Professor Wilms says that in the Heidelberg Clinic, which is known for its large proportion of abdominal operations, in the year 1912, 54 per cent. of all operations were done under local anæsthesia. Through the writings of Braun, Hirschel and Fischer in Germany and of Crile, Harris, Hertzler, Bevan and Allen in America, novocaine has come to be looked upon as the ideal drug for local anæsthesia, almost entirely superseding other relatively non-toxic substances, such as alypin, tropacocaine, stovaine, eucaine and aneson.

The low index of toxicity of novocaine makes it possible to perform under regional anæsthesia more extensive operations than were possible by the methods of Schleich or with any of the older local anæsthetics. M. L. Harris removed the cæcum and ascending colon and made an ileocolostomy, in a person sixty years of age, under novocaine by blocking the ninth, tenth, eleventh and twelfth dorsal and first lumbar nerves on the right side. By Braun's massive infiltration the writers have found it a comparatively simple matter to amputate without pain the leg and arm, to make double amputations of the breast, etc., using novocaine-adrenalin alone. It has not been unusual to employ as much as a gramme of novocaine for one operation, and in the double breast amputation mentioned 1.6 grammes were used.

Hirschel in his book remarks that novocaine "satisfies all the demands which Braun postulates for a local anæsthetic, namely, that the latter should be less toxic than cocaine proportionately to its local anæsthetizing power, that it should not cause any damage to the tissues, that it should be soluble in water and easy to sterilize when in solution, and, finally, that it should be capable of being combined with some adrenal preparation." The fatal dose of novocaine in rabbits when injected subcutaneously is stated by Hirschel to be about 0.73 gramme per kilogramme of body weight, thus the toxicity of novocaine compared with the toxicity of cocaine is as one to seven. Idiosyncrasy

to novocaine has been observed in some individuals. The toxic symptoms, as noted by Laewen, Liebel, Krecke, Hirschel, Fischer and Balzer, are nausea, restlessness, acceleration of the respiration, sweating, pallor, disturbances of vision and deafness. After the administration of large doses, Hirschel has observed clonic-tonic spasms and opisthotonos.

The low toxicity of novocaine when injected subcutaneously having been established by clinical experience, it has been believed by many that the very rare fatalities attending the use of the drug have been due to the injection of novocaine directly into a blood-vessel, usually a vein; for example, a hemorrhoidal vein, a vein of the neck or of the floor of the mouth.

Professor Bier (*Berl. Klin. Woch.*, March 15, 1909) calls attention to the danger of poisoning from intravenous injections of novocaine. Bier's method, as is well known, can be applied only to the extremities. After all blood is expressed from the extremity with the soft rubber bandage rolled from the distal end to a level above the field of operation, a second rubber bandage is wound about the extremity below the field of operation. A subcutaneous vein of this ischæmic segment is exposed and novocaine solution is introduced through a metal cannula. Bier regards 80 c.c. of $\frac{1}{2}$ per cent. solution of novocaine as the largest that can be given with safety, although he has given much larger doses without toxic symptoms. It is well known that the toxic effect of all poisons is more prompt and pronounced after injection directly into the blood stream than it is after subcutaneous or intramuscular injection.

The possibility of serious consequences of intravenous injection of novocaine even in areas rendered quite ischæmic by rubber bandages is suggested by Hitzrot (*ANNALS OF SURGERY*, October, 1909). After completing operations done under intravenous novocaine anæsthesia, he washes out the veins with warm salt solution as an additional precaution. The upper rubber bandage is then loosened sufficiently to allow the blood to flow through the arteries and thus to wash out more of the novocaine solution. After the blood has flowed for a few minutes he again tightens the bandage and sponges the wound dry and closes it in the ordinary manner. After intravenous injection of novocaine in zones of artificial ischæmia, Bier observed two cases of slight poisoning. In these cases there was dizziness with vomiting but no serious phenomena.

In the animal experiments, reports of which follow, an attempt has been made to determine approximately the index of toxicity of novo-

TOXICITY OF NOVOCAINE-ADRENALIN

caine and adrenalin injected intravenously. The injections were made in the marginal ear vein of rabbits. All solutions were warmed before injecting.

EXPERIMENTAL PROTOCOLS

I. INTRAVENOUS INJECTIONS OF SMALL DOSES OF NOVOCAINE-ADRENALIN CHLORIDE IN RABBITS

Rabbit No. 1.—Weight, 2.15 kilogrammes. This rabbit received a dose of 4 minims of $\frac{1}{2}$ per cent. novocaine (0.0012 gramme) and one minim of 1-5000 adrenalin chloride. Pulse before injection, 156 per minute. After injection rabbit got up at once and walked about. Two minutes after injection the pulse-rate was 102 per minute, and five minutes after injection the pulse was 214 per minute. Respiration was normal excepting immediately prior to the injection, at which time the usual struggling of the animal occurred. This rabbit had no observable reaction of any nature after the lapse of one hour.

Rabbit No. 2.—Weight, 2.35 kilogrammes. This rabbit received a dose of 6 minims of $\frac{1}{2}$ per cent. novocaine (0.00186 gramme) and one minim of 1-5000 adrenalin chloride. Heart-rate, too rapid to count before injection. Two minutes after injection, pulse was 196 and one minute later was 210 per minute. The rabbit remained perfectly quiet and the respirations were irregular. Five minutes after the injection the pulse could not be counted. No further phenomena occurred in the next hour.

Rabbit No. 3.—Weight, 2.5 kilogrammes. This rabbit received a dose of 7 minims of $\frac{1}{2}$ per cent. novocaine (0.00217 gramme) and one minim of 1-5000 adrenalin chloride. Pulse-rate before injection was 174. Respirations were shallow and rapid. Respirations increased in rapidity and became more shallow. The rabbit remained very tranquil. The pulse-rate two minutes after the injection was 90. Within a minute afterwards the rabbit began to move about somewhat. Nine minutes after the injection the pulse was 216 per minute and the rabbit was apparently normal, there being no further change during the succeeding hour.

Rabbit No. 4.—Weight, 2.35 kilogrammes. This rabbit received a dose of 8 minims of $\frac{1}{2}$ per cent. novocaine (0.00248 gramme) and one minim of 1-5000 adrenalin chloride. Pulse-rate previous to injection, 168 per minute. Two minutes afterwards pulse was 300 and the rabbit was very active, running about upon the table. No further change in the next hour.

The same rabbits were used in the following experiment as in the preceding, and numbered similarly.

II. INTRAVENOUS INJECTIONS OF NOVOCAINE ALONE (SMALL DOSES)

Rabbit No. 1.—Received 10 minims of $\frac{1}{2}$ per cent. novocaine solution (0.0031 gramme) diluted with three parts of sterile distilled water. Heart-rate before injection, 136 per minute. One minute after the injection, the heart-rate was 168. There were no symptoms in the next 20 minutes. Twenty-five minutes after this injection the pulse-rate was 168. One-half hour after the first injection 3 c.c. of a $\frac{1}{2}$ per cent. novocaine solution (0.015 gramme) was injected into

the ear vein and two minutes later the heart-rate had dropped to 108; the rabbit remained very tranquil. Three minutes after the injection the heart-rate was 156. The rabbit showed no other disturbance.

Rabbit No. 2.—Received 12 minims of $\frac{1}{2}$ per cent. novocaine solution (0.00372 gramme) diluted three volumes as in the other experiments. The heart-rate before the injection was 174 per minute. Two minutes after the injection the heart-rate was 114 per minute and irregular and the respirations were markedly slow. The rabbit remained very quiet. Three minutes later the rabbit became active, running about over the table.

Rabbit No. 3.—Received 7 minims of $\frac{1}{2}$ per cent. novocaine (0.00217 gramme) diluted as usual. Before the injection the heart-rate was 192 per minute and the respirations were only 30 (very slow for a rabbit).

The second injection of $\frac{1}{2}$ per cent. novocaine (0.00434 gramme) was given two minutes later and almost immediately the heart-rate dropped to 84, no other symptoms being present.

Rabbit No. 4.—Received 55 minims of $\frac{1}{2}$ per cent. novocaine solution (0.01705 gramme) diluted with an equal volume of sterile distilled water. The heart-rate before injection, 136 per minute; one minute later, heart-rate 216 per minute. No other symptoms present.

III. INTRAVENOUS INJECTIONS OF ONE-HALF PER CENT. NOVOCAINE MADE WITH STERILE NORMAL SALT SOLUTION (LARGE DOSES)

Rabbit No. 1.—Received 6 c.c. of $\frac{1}{2}$ per cent. novocaine (0.03 gramme). Heart-rate before injection, 166. Respirations very rapid and very irregular. One minute after injection the heart-rate was 212 per minute. Rabbit remained very quiet and showed no further symptoms.

Rabbit No. 2.—Received 8 c.c. of $\frac{1}{2}$ per cent. novocaine solution (0.04 gramme) in ear vein. Heart-rate before injection, 240 per minute. This was a very thin rabbit. One-half minute after injection the rabbit lying on its back, straightened rigidly. First a partial and then a complete paralysis of fore and hind legs developed. Respirations were extremely rapid and the head was retracted. One-half minute later, or a minute after the injection, the rabbit had recovered the use of both fore and hind legs and was apparently in as good condition as before the injection. The heart-rate was 192.

Rabbit No. 3.—Received 10 c.c. of $\frac{1}{2}$ per cent. novocaine (0.05 gramme) in the ear vein. This was a plump rabbit and the heart-rate before injection was 162 per minute. Within 30 seconds following injection, the head became retracted and the legs extended in complete paralysis. There occurred spastic movements of the entire body and a decided increase in the respiration rate. Some tremors were noticed even during the injection. Finally, there was utter relaxation and the respirations were very slow. Two minutes after the injection had been given we resorted to artificial respiration and a minute later to cardiac massage. Three minutes after injection the respirations were very rapid and the heart-rate could not be counted. At this time there was a very hard circumscribed mass which could be palpated under the ribs and in the region of the heart. We took this to be the heart. Six and one-half minutes after injection the rabbit was rallying and the heart was 166. One-half hour after injection the heart-rate was 138 and the rabbit was apparently normal.

TOXICITY OF NOVOCAINE-ADRENALIN

Rabbit No. 4.—Received 10 c.c. of $\frac{1}{2}$ per cent. novocaine (0.05 gramme) in the ear vein. This rabbit was plump and extremely active. The respirations were very fast and the heart-rate could not be counted before the injection. There was little effect from the injection except a paresis of the hind legs which occurred during the first two minutes following injection. The rabbit crawled about slowly at the time that the paresis was present, dragging the hind legs. Five minutes after the injection the rabbit was tranquil. One hour later the rabbit was apparently normal.

IV. INTRAVENOUS INJECTIONS OF NOVOCAINE ADRENALIN CHLORIDE IN LARGE DOSES

Rabbit No. 1.—Heart-rate before injection, 186 per minute. Received 7 c.c. of a solution containing 10 c.c. of $\frac{1}{2}$ per cent. novocaine (0.035 gramme) and 8 minims of 1-5000 adrenalin chloride in the ear vein. While the injection was being given a convulsion occurred. Within 30 seconds of the time of the injection the following phenomena occurred: The rabbit fell over on its right side with complete paralysis of both front legs and both hind legs and with marked retraction of the head. The eyes bulged and the pupils were enormously dilated. One minute after the injection the rabbit raised its head and a minute later was able to move its front legs. Three minutes after the injection the hind legs were still paralyzed. The respirations at this time were about the same as before the injection. The paralysis of the hind legs was still present nine minutes after the injection and the animal was very unsteady as regards movements of the front legs. Twelve minutes after the injection the rabbit was sitting tranquilly in the same spot where he first sat up and was disinclined to move. A half hour after the injection the rabbit was still in the same posture, but the paralysis of the hind legs had disappeared.

Rabbit No. 2.—Heart-rate before injection could not be counted. Received 10 c.c. of $\frac{1}{2}$ per cent. novocaine solution (0.05 gramme) and 12 minims of adrenalin chloride, 1-5000 solution in the ear vein. Within 45 seconds a convulsion with paralysis of the front legs occurred and one-half minute later the hind legs were paralyzed. The bulging eyes with enormous dilatation of the pupils were present. There was great increase in the heart and respiration rate. The head was retracted and the rabbit frequently shook its head and gave indications of air hunger. During the first minute and a half following the injection, choreic movements were present. Three minutes after injection the head was still retracted, breathing was shallow, all the legs were paralyzed but the rabbit batted its eyes and tried to get up. The rabbit arose six minutes after injection with a partial paralysis of the hind legs. The legs were dragged as the animal crawled about the table. Seven and one-half minutes after injection the rabbit moved about without any trouble and was apparently normal.

Rabbit No. 3.—Heart-rate before injection 252 per minute. Rabbit received $9\frac{1}{2}$ c.c. of a mixture containing 10 c.c. of $\frac{1}{2}$ per cent. novocaine solution (0.0475 gramme) and 15 minims of 1-5000 adrenalin chloride. Injection was given in the ear vein. Thirty seconds after the injection there was marked bulging of the eyes and enormous dilatation of the pupils. There was immediate paralysis of respiration and the rabbit fell upon its side, the head being retracted with complete paralysis of both front and hind legs. The rabbit jerked its head but did not breathe, moving and wrinkling its nose as if air hunger were intense. We were compelled to resort to artificial respiration within one minute

after the injection had been given. The heart stopped $3\frac{1}{2}$ minutes after the injection, but after about 10 seconds of massage of the organ through the chest wall, it began to beat again. Four minutes after the injection there were no observable respiratory movements and the rabbit lay as if dead. Four and one-half minutes after the injection, the rabbit began to bleed from the mouth. The heart-beat could not be detected at this time. Seven and one-half minutes after the injection the rabbit was apparently dead. We opened the chest at this time and found that the heart was still beating. Respiration had ceased.

Rabbit No. 4.—Heart-rate 132 and very irregular before injection. The rabbit received 8.75 c.c. of $\frac{1}{2}$ per cent. novocaine solution (0.04375 gramme) and 20 minims of the 1-5000 adrenalin chloride solution. Within 45 seconds following the injection spasmodic movements with bulging eyes and enormously dilated pupils appeared. Choreic movements were present and air hunger was pronounced. There was a complete paralysis of both front and hind legs, but all four legs jerked stiffly from the trunk, there being no flexion at any joint. The rabbit was very quiet one and one-half minutes after the injection. At this time the respirations were rapid but regular. The heart was so rapid that the rate could not be counted. The bulging of the eyes was not marked. Three and one-half minutes after the injection the respirations were much slower as was likewise the heart-rate, and the rabbit tried to sit up, accomplishing this act with difficulty. There was complete paralysis of the hind legs at the time the rabbit first sat up, the legs being stretched out rigidly. This paralysis passed away a half-minute afterwards.

V. INTRAVENOUS INJECTIONS OF NOVOCAINE ALONE IN LARGE DOSES TO DETERMINE THE LETHAL DOSE IN RABBITS

Rabbit No. 4.—Received 10 c.c. of $\frac{1}{2}$ per cent. novocaine solution (0.05 gramme). Within the first twenty seconds following the injection the rabbit fell upon its back and was shaken with convulsive movements. The head was retracted, the eyes were bulging and the pupils were dilated. Both front and both hind legs were paralyzed. The rabbit wrinkled its nose and kept the mouth open and air hunger was pronounced. Respirations were slow and shallow. One and one-half minutes after the injection the rabbit was apparently normal, moving about upon the table in a lively manner and giving no evidence of the leg paralysis or any other symptoms.

A half hour after the first injection, 30 c.c. of $\frac{1}{2}$ per cent. novocaine solution (0.15 gramme) was injected into the peritoneal cavity without producing any symptoms.

Rabbit No. 2.—Received 15 c.c. of $\frac{1}{2}$ per cent. novocaine solution (0.075 gramme). Twenty seconds after the injection the following symptoms appeared: retraction of the head, the rabbit having fallen upon the back, dilated pupils, bulging eyes, pronounced air hunger, shallow, slow respirations, and the mouth open widely. At this time paralysis of both front and both hind legs was observed. The rabbit sat up four minutes after the injection, paralysis of both hind legs still being present. Five minutes after the injection all symptoms had disappeared and the rabbit was apparently normal.

Rabbit No. 1.—Received 20 c.c. of $\frac{1}{2}$ per cent. novocaine (0.1 gramme). Just as the last 2 c.c. were being injected the respirations stopped, this following immediately upon the phenomena of head-retraction, falling upon the back,

TOXICITY OF NOVOCAINE-ADRENALIN

pronounced air hunger and paralysis of all four legs. The mouth remained open and the rabbit made desperate efforts to obtain air. The heart was beating one minute after the injection but the rabbit was apparently dead at this time. Death was deemed to be due to respiratory failure. The heart-beat could be felt two minutes after the injection, but stopped in the following minute. Bleeding from the needle puncture in the ear vein was profuse.

CONCLUSIONS

(1) The index of toxicity of novocaine-adrenalin when administered intravenously in the proportions given above is, as would be suspected, much higher than when given subcutaneously. Hirschel, as was noted, found the fatal dose of novocaine by subcutaneous injection in rabbits to be 0.73 gramme per kilogramme of body weight. If injected intravenously, the average fatal dose in rabbits of novocaine-adrenalin in the usual proportions is probably somewhat less than 0.02 gramme per kilogramme of body weight. In these experiments the lethal dose of novocaine combined with adrenalin chloride when administered intravenously in rabbits was 0.019 gramme per kilogramme of body weight. When using novocaine alone it was observed that the amount of novocaine necessary for a lethal dose was $2\frac{3}{5}$ times the dose required when combined with adrenalin chloride, that is, the lethal dose of novocaine alone was 0.0456 gramme per kilogramme of body weight. Thus, the toxicity of novocaine injected intravenously appears from these experiments to be about 16 times greater than when injected subcutaneously.

(2) It was observed that two rabbits died of respiratory failure.

(3) The fatal dose being many times smaller by intravenous injection than by subcutaneous injection, it follows that caution should be employed in injecting novocaine-adrenalin solution that the point of the needle does not enter a blood-vessel, since especially in individuals having idiosyncrasy against novocaine or adrenalin serious harm may be done.

(4) Indifferent dosage and careless use of novocaine solution in subcutaneous injection is inexcusable although in persons not having an idiosyncrasy against novocaine there is a considerable margin of safety if less than two grammes are used.

(5) Since accidental introduction of the solution into a vein may occur during subcutaneous or intramuscular injections of novocaine-adrenalin, the approximate intravenous lethal dose of this combination, that is, 0.019 gramme per kilogramme of body weight should be borne in mind. However, the likelihood of injections by accident of a gramme

or more of novocaine in $\frac{1}{2}$ per cent. solution intravenously must be considered remote, owing to frequent changing of the position of the needle point.

(6) As it is impossible to know beforehand of the existence of an idiosyncrasy, the injection should always be very gradual and cautious. It is prudent to inject a few cubic centimetres of the customary $\frac{1}{2}$ per cent. solution and then wait for 10 or 15 minutes for the development of toxic phenomena which usually appear promptly in individuals having the idiosyncrasy.

(7) Novocaine-adrenalin when injected subcutaneously in the usual proportions and amounts may be regarded as practically safe except in individuals having the idiosyncrasy.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting, held January 3, 1916

The President, DR. JOHN H. GIBBON, in the Chair

CARCINOMA OF UNDESCENDED TESTICLE

DR. CHARLES F. NASSAU reported a case of carcinoma of an undescended testicle occurring in a man aged forty-one years, who was operated upon in January, 1912, and is still living, indicating that carcinoma of a testicle is probably not as fatal a condition as sarcoma.

Three months before admission he had an attack of pain in lower abdomen, with inability to empty bladder. Left testicle is not palpable in canal or scrotum. Admitted to hospital June 15, 1912, with another attack of pain in pelvis, with inability to empty bladder. There was a large freely movable firm mass present in the abdomen above the pubes. No testicle could be felt in scrotum or canal on left side. Rectal examination: Large freely movable mass palpable in pelvis.

An incision, 5 inches long, made through left rectus, exposed a large mass which proved to be the testicle. It was delivered, pedicle tied off and tumor cut away. Peritoneum was sewed over the stump. No glands palpable. Appendix was found to be inflamed and it was removed.

The tumor was an ovoidal mass, measuring $10 \times 7.5 \times 5$ cm., weight 547.5 gms. Pathologist report: Scirrhus carcinoma. About the middle of the specimen is a whitish constricting band. The specimen is smooth, moist, glistening and firm to the touch. Incision meets with no resistance, revealing moist, lobulated, glistening yellowish-white tissue. Thin serum can be expressed from the entire surface.

PSEUDO-DIVERTICULUM OF GALL-BLADDER

DR. GEORGE G. ROSS gave the history of a woman, aged forty-four years, who, three weeks subsequent to an operation for acute appendicitis, developed an acute cholecystitis. On November 23, 1915, she was operated on through a right rectus incision. The gall-bladder was free from adhesions. It seemed to empty itself on pressure, and outside of

some thickening of the wall did not seem to be badly damaged. As the history and symptomatology, including a cholesterin test, were so positive a cholecystectomy was done. When the gall-bladder was opened it was found to be a typical strawberry bladder at the fundal end. At the fundus near the attachment to the gall-bladder a marsupial-like pouch was discovered. The opening was patulous and the pocket appeared to be about one inch deep. The mucous membrane surrounding the orifice of this pouch was the point of the most intense inflammation.

Pathological examination by Dr. Allen J. Smith. In his opinion this pouch was probably an acquired and not a congenital one. The pouch (not a diverticulum) was over a centimetre in diameter and communicated with the general cavity of the gall-bladder by a short, narrow mouth. It was lined by continuation of the mucosa of the bladder and was the seat of marked hyperæmia. The wall of this pouch of the gall-bladder was incised in the longitudinal line of the pouch; and a portion of the tissue on one side of this incision was prepared for microscopic examination.

On examination one side only (thought to be that which corresponds with the interior of the bladder proper) shows a mucosal surface, thin, with villous prolongations, its epithelium largely desquamated and that which remains low, cuboidal, and degenerative. No such appearance is seen on the opposite (corresponding with the lumen of the pouch) side, this surface being free from epithelium and finely fringed with loosened fibrous tissue (artificial tearing or material?). A layer of smooth muscle underlies the mucosal surface (but not the outer surface). Beyond this muscle the tissue to the free surface (of pouch?) is made up of a loose fibrous tissue. The latter is not as dense as one is accustomed to see in a scar but might have been produced by inflammatory change.

The general appearances can be best tentatively explained by supposing that an inflamed and ulcerous surface has had overhanging mucosal borders, that these later adhered to the interior of the pouch thus formed, healed, with a persisting track into the gall-bladder, but the epithelium of the gall-bladder failed to grow into and line the cavity.

FOREIGN BODY IN ELBOW-JOINT (MOUSE)

Dr. Ross presented a man, aged thirty years, who two years ago while pitching ball says he felt something crack in his elbow. He had to stop pitching for the rest of the season. The following season he pitched some although his elbow continued to hurt him. About four months ago he bumped the elbow and felt something loose, after this, in



FIG. 1.—Pouch of gall-bladder.



FIG. 2 —Bit of the external condyle broken off, and forming a loose body in the elbow-joint. *B* the fragment removed

FOREIGN BODY IN ELBOW-JOINT

the outer side of the joint. An X-ray of the elbow a week ago showed a fracture of the external condyle of the humerus. On the outer side of the elbow just above the joint can be felt a small movable body about the size of a hazel-nut. This is hard and slips when the arm is moved.

Through an incision made over the mass it was easily found and removed. It proved to be a piece of bone the size of a hickory nut, covered with cartilage. It was unattached and was to the outer side of the external condyle.

A perfectly normal functional result was secured.

DR. JOHN H. JOPSON said that Dr. Ross's case of "joint mouse" belongs to that group of cases of fracture of the capitellum which has been especially studied by Kocher and Lorenz, to which he alluded in his paper on that subject published two years ago, and called by them "*fractura capituli humeri partialis*," in contradistinction to the larger group of fractures of the capitellum in which there is a splitting off in whole or in part of that articular prominence. In the first group the injury partakes of the nature of partial or complete avulsion of the cartilage covering the capitellum, to which portions of the spongy tissue of the bone may also adhere. Kocher has reported four cases and Lorenz two cases of this injury.

It is of infrequent occurrence and in the majority of cases is due to indirect violence, possibly, as Kocher points out, by traction through the anterior capsular attachments pressing backward on the cartilage and prying it off, as when the injury occurs while lifting with the forearm extended. The X-ray shows, as in Dr. Ross's case, irregularity in outline of the normal shadow of the capitellum. Treatment, of course, is by incision and removal of the fragment, which in all of the cases reported has given uniformly good results.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

Stated Meeting, held January 26, 1916

The President, DR. CHAS. N. DOWD, in the Chair

TRANSPERITONEAL NEPHRECTOMY FOR CONGENITAL MIXED TUMOR OF THE KIDNEY

DR. EDWIN BEER presented a woman, aged twenty-two years, who for three years had suffered every few months from cramp-like pains in the right lower quadrant of the abdomen. At the same time had noted the presence of a tumor in the right half of the abdomen. She had lost twenty-two pounds in weight. The tumor had not increased in size, and when admitted the tumor was found to extend well across to the mid-line of the abdomen and to lie external to the colon.

April 24, 1915, Dr. Beer operated by the transperitoneal route for the removal of the tumor-bearing kidney. A seven-inch, rectus-splitting incision exposed the tumor. The peritoneum over the tumor was widely incised, and then pushed aside, exposing the ureter and the vascular pedicle. These were carefully ligated and then the tumor dissected free. No metastases in glands, liver, or vessels detected. Patient made an uneventful recovery and was discharged on May 8th.

NOTE.—When this method of approaching giant tumors of the kidney was first suggested (Israel, etc.), it was thought that by getting at the pedicle at once all chance of dislodging pieces of growth that had invaded the renal veins would be avoided. This method of approach does, in a measure, accomplish this, although usually considerable manipulation must precede the location and ligation of the pedicle. That it is, however, a much simpler method of approach for these very large tumors than the lumbar route no one, who has had experience with both, will deny. It allows of search for intraperitoneal deposits, it allows of earlier ligation of the vessels, it gives much better exposure throughout the operation, and in case a deposit has grown into the vena cava it can be more readily extracted.

HYPERNEPHROMA COMPLICATED BY PREGNANCY; NEPHRECTOMY

DR. BEER presented a woman, aged thirty-two years, who since three years had known of the existence of a tumor in the right hypochondrium, which had doubled in size during the last year. She was over four months advanced in pregnancy.

HYPERNEPHROMA COMPLICATED BY APPENDICITIS

Examination showed a symmetrical tumor in the hypogastrium corresponding to a four-months pregnancy, and in the right side of the abdomen a very large, slightly nodular, mass, which ballotted from the lumbar region and was slightly movable. The large nodules on the anterior surface were somewhat cystic to touch and suggested the possibility of a cystic degeneration.

June 3, 1915, a transperitoneal nephrectomy was done through a six-inch, muscle-splitting, right-rectus incision, exposing the tumor. The posterior parietal peritoneum over the tumor was incised widely and pushed back from over the tumor, exposing the ureter and the vascular pedicle. These were carefully ligated, the latter close to the vena cava, which, as well as the renal veins, was not involved. The whole mass was then readily delivered and the posterior peritoneum was closed by suture. Layer suture of the anterior incision, without drainage. The patient made an uneventful recovery and went to term, having a normal labor.

Pathological report: hypernephroma.

HYPERNEPHROMA COMPLICATED BY APPENDICITIS AND LUES: NEPHRECTOMY

DR. BEER presented a woman, aged thirty-eight years, who one year ago began to suffer dull and constant pain in right lower abdomen, and she noted in this region a hard mass which has not altered in size. In addition to the dull pain, attacks of severer pains, lasting four to five hours, soon set in, and these were accompanied with frequency of urination. About four months prior to admission serpiginous ulcers appeared on the right leg and responded to local treatment very slowly.

Physical examination showed a very pale woman with Hb 65 per cent. In the right half of the abdomen was a slightly irregular, ovoid mass the size of an adult head. It was movable from side to side about one inch, and a little more so in the vertical direction. On the right leg there were several definitely specific ulcerations. The Wassermann was strongly positive.

On the strength of the examinations the diagnosis rested between a specific renal involvement and a neoplasm. Just prior to operation the patient had severe attack of right iliac pain which was thought to be due to the renal condition, but proved on operation to be due to an acute appendicitis.

June 5, 1915, transperitoneal nephrectomy and appendicectomy were done. Seven-inch, rectus-splitting incision and peritoneum opened. Acutely inflamed appendix seen in lower angle and removed. Peri-

toneum over the kidney mass opened and stripped back so as to liberate the mass. There was some difficulty in pushing the hepatic flexure off the mass. It was flattened out over and adherent to the tumor. The posterior surface of the huge tumor was slightly adherent in its bed, making it rather difficult to free. Early in the dissection the ureter was exposed and doubly ligated and then the broad vascular pedicle which was not involved was ligated, so that subsequent manipulations would not force any neoplastic tissue into the circulation. Vena cava was widely exposed and found free. Tumor and perirenal fat were removed *en bloc*.

The recovery was uneventful and on June 17 another phthalein test was made and 56 per cent. recovered in two hours. In other words, after removing the right kidney the left was working better than at the previous examination.

Pathological report showed the mass to be a hypernephroma.

DR. CHAS. N. DOWD said that the transperitoneal method of nephrectomy is surely more complicated than the retroperitoneal method, but the advantage of early pedicle ligation in cases of malignancy should be considered. It would be interesting to hear the experiences of other members of the society with this method.

DR. WM. A. DOWNES said that he had only removed one kidney through the anterior incision. Most of the large kidney tumors that he had had, had been in children. He had used the transverse incision practically altogether, and had found this incision very satisfactory. The pedicle has never given any trouble. The metastasis question is, of course, a very pertinent one in all of these cases. He had frequently found that there were masses leading from the renal vein to the vena cava. All but two of eleven cases had died from a general metastasis, which has occurred very quickly.

He asked whether, in exposing these tumors transperitoneally, the presence of large retro-peritoneal veins which run across the tumor add to the dangers. He asked this because about three years ago at a meeting of the Society, at the New York Hospital, he showed a woman from whom he had removed a large adenocarcinoma of the kidney which had been previously exposed by an anterior incision. The surgeon who did the first operation encountered veins so large that he feared that a hemorrhage would probably be fatal, and did not attempt to remove the kidney. The woman went away and in a month or two came back and said that she was still greatly troubled by the tumor. When approached from the back it was removed without difficulty.

DR. HOWARD LILIENTHAL thought that Dr. Beer had brought up an important point when he discussed the propriety of removing the hypernephromatous kidney when there are secondary growths present. He believed that modern authority has it that even in the presence of metastases the kidney should be removed when, through hemorrhage or pressure, it threatens the life of the patient. Operable secondary growths should also be extirpated. About a year ago Dr. Lilienthal removed a hypernephromatous kidney from a woman who had a large metastasis in the dome of the liver. She has remained well up to the present time, although naturally the metastasis is still present. It is difficult to judge of the malignancy of these tumors, and particularly of certain metastases. He had seen one patient, for example, who lived for three years with a metastasis in his right femur. When there is an obviously terminal condition with cachexia no operation can do good, but the mere presence of secondary tumors should not necessarily deter us from performing a nephrectomy with the object of prolonging life.

DR. BEER, in closing, said that he had had no trouble at all from the colic vessels. Of course, the posterior peritoneum, if uninvolved, usually strips off the tumor very readily. If one gets in the right cleavage line, one can push back all the vessels with the gut, just as in extensive colic resections. As far as children are concerned, it depends upon the size of the growth, as to the line of approach. These giant tumors do not look very large when they have shrunk outside of the body, but in one of these cases, the X-ray shadow fills the whole right side of the abdomen and extends two inches across the median line into the left half of the abdomen. It is practically impossible to deliver such a growth through a lumbar incision, as there is not sufficient space between the iliac crest and the ribs. Consequently, even in children, he would use the transperitoneal approach through a vertical incision. The important points are to determine whether there are secondary intra-abdominal deposits, as well as to get at the pedicle with as little manipulation as possible. Recently, in one of these enormous tumors, filling the whole left side of the abdomen, a case of (microscopic) hypernephroma, he found a huge secondary deposit in the dome of the left lobe of the liver. He immediately closed the patient's wound. There was no object in removing the large primary growth together with the involved splenic flexure. If one makes a big enough transverse cut one can open the peritoneum and explore, but not as readily as through an anterior incision. Moreover, in this approach, the vascular pedicle is reached late, and whatever the advantage of tying off this

pedicle early may be, it is surely lost if extensive manipulations precede the ligation, as is the case in all lateral and lumbar incisions.

THE IMMEDIATE REDUCTION OF FRACTURES

DR. WILLIAM DARRACH read a paper with the above title, for which see page 593.

DR. HOWARD D. COLLINS said that one must bear in mind that, in the early reduction of fractures, if a plaster-of-Paris dressing is to be applied at once, one must allow for subsequent swelling. It will occur, and one must put that splint on much looser than one would in the ordinary cases where the fracture is reduced at the end of three or four days. In his experience, he had to cut down plaster more frequently in the early reductions than in the later reductions, simply on account of his own omission to note the importance of leaving plenty of room.

DR. ARTHUR S. VOSBURG said that the way he used to get around the difficulty of the swelling which is apt to follow is, after making reduction, and if a circular incasement of plaster is to be used, he splits it down with a scalpel at the time, before the splint hardens, to allow for any subsequent swelling. The encircling plaster cast will gape, if any swelling occurs in the next forty-eight hours, and any subsidence of the swelling can be met by drawing the split cast together with adhesive straps.

DR. LILIENTHAL said that, in taking into account the swelling in cases of fracture, much depends on just how early the injury is seen. In performing osteoclasis or linear osteotomy for bow-legs, for example, or for some other deformity, surgeons are accustomed to apply immediately a firm compressing dressing taking in the entire limb from the most distal part to a point well above the fracture, and yet they do not fear the swelling. If a case of fracture of a long bone is seen soon after the injury and before swelling has occurred, it may be treated in much the same manner as would be employed in a case of osteoclasis.

Another point, though perhaps not quite germane to the question, is the matter of ambulant treatment, more particularly in fractures of the leg. It has been his procedure to employ a Hessing splint as soon as the apparatus can be made. With this splint a patient with Pott's fracture can be walking about within a very few days. Owing to the expense of this appliance the method is not applicable to the usual hospital cases, but in private practice it is most satisfactory. His results have been good. The treatment of every case, however, depends

THE IMMEDIATE REDUCTION OF FRACTURES

on the circumstances which surround it and there can be no hard and fast rules. In children with fractures of the arm or forearm pressure should not be used because of the danger of ischæmic paralysis.

DR. BEER said that immediate reduction, that is, proper immediate reduction, complete reduction, is not as easy of accomplishment in certain bones as in others, and under present conditions is not always possible. One has, therefore, to differentiate between two types of cases. In fractures around the wrist or a fracture in some part of the hand, or a fracture around the ankle, where the bones can very readily be felt through the overlying skin, an immediate complete reduction can be secured. But in fractures which are surrounded by heavy muscles, fractures of the humerus, of the thigh and the like, it is much more difficult to obtain complete reduction, as the bones can not be definitely palpated. Their immediate reduction is also indicated, but it should be done under the control of the fluoroscopic screen, as otherwise reduction will frequently be incomplete and unsatisfactory. In order that one may get immediate complete reduction in both classes of cases, every one of our large hospitals (Bellevue Hospital, particularly, where fracture material comes in such quantity) ought to have a special X-ray room for fracture cases, so that a patient can be put under an anæsthetic and have his fracture promptly reduced under fluoroscopic control, instead of waiting for X-ray plates made at the convenience of the X-ray laboratory. Under the system in vogue, plates are taken first, then reduction is made, then re-X-ray, and if position is unsatisfactory, re-reduction.

DR. JOSEPH WIENER said, judging from the discussion, plaster-of-Paris seems to be the only method of treating fractures. Personally, he had not used plaster-of-Paris for over ten years. He did not expect to use it for the next ten years. He had been using what we call "starch and veneer dressing." It is astonishing how little it is known. This starch and dextrin can be bought in yard widths and cut down into bandages and made with an ordinary bandage roller. The veneering one must get from a piano factory. When that is wet, it can be moulded accurately to shape any part of the extremities of the body. There is no danger of any constriction. There is no danger of paralysis, and the didactic rules that Dr. Connell rightly laid down in the use of plaster-of-Paris fall away completely. Furthermore, the difference in weight is perfectly marvellous. He had numerous patients who had had fractures of the leg and thigh treated with plaster-of-Paris and subsequently been treated with this. They call the first treatment barbarous and the second treatment delightful.

Dr. Wiener also presented two cases in which there was no immediate reduction of the fracture, to show what might be done subsequently. The first case was a little girl of five years who was in the hands of a practitioner of the old school. The little girl fell on the street about three years ago. When the doctor saw her about two hours later there was a good deal of swelling in the knee-joint and there was a good deal of bruising of the soft parts, and he made a diagnosis of injury to the knee-joint. He kept the child in bed for about ten days with ice-bags. The swelling in the joint went down, the pain subsided. After about two weeks he allowed this child to get up. The child then was unable to walk. The mother noticed it, became very much alarmed, and asked for further advice. The speaker then saw the case, about two weeks after the injury. Measurements showed a shortening of about an inch and a quarter of the lower extremity, on the injured side.

The child had a transverse fracture of the femur, with little callous formation. It was still possible to separate the ends of the bone without much difficulty, and a rather powerful assistant could pull the lower fragment down. The moment he let go, the lower fragment snapped back. To keep the bones in place he put in a Lane plate in the child's femur. The wound healed by primary union. There was a great deal of callus formed. The child is still carrying the plate. The child is still absolutely well and free from all symptoms.

The second case is a case which is still under treatment. Two and a half weeks before admission he was struck by a trolley car, which hit him in the left arm. The car, going at full speed, knocked him down. He was dazed. When he recovered, he found he didn't have the use of his left arm and there was pain and swelling of the arm. He went to a dispensary, where his arm was put up at a right angle with an immobilizing dressing. No attempt at that time was made at reduction. The man's pain got worse instead of better and when he entered the hospital he had a flexion angle of fifty degrees, an extension angle of twenty. Palpation showed the distal fragment on the inner side of the arm, about three inches above the elbow. The proximal fragment could not be made out, but the distal fragment was almost under the skin.

On January seventeen, two and a half weeks after the injury, an incision was made on the outer aspect of the arm and a large, loose piece of bone removed. There was a small piece of bone with some periosteum attached, which was left in place. Much difficulty was experienced in overcoming the deformity. The bones overlapped con-

siderably and there was a very marked flexion of the lower fragment. He resected about three-eighths of an inch from the ends of the fragments and put in an intermedullary splint taken from the tibia.

DR. KARL CONNELL remarked that it was to be regretted that the hospital routine of obtaining scientific data occasionally works to the detriment of the patient. This has occasionally happened in the treatment of fracture at the Roosevelt Hospital clinic. Not infrequently, in an effort to record the primary malposition by X-ray, the reduction of recent fracture would be delayed for twenty-four hours or more. There is no clinical advantage if it involves delay, in waiting for X-ray before reducing the average fracture of the wrist and ankle. He believed they should be promptly reduced and the resultant position only recorded. It certainly works for the ease of reduction, the comfort of the patient and more rapid recovery of full function of the soft parts, to reduce promptly.

As to the circular plaster splint, while this is the most economical distribution of material for strength and immobilization, yet no circular plaster splint on recent fracture of the forearm or leg should be left completely encircling the limb after it hardens, but the freshly applied circular splint should be cut down in a line to allow it to gape in case the limb swells. To the student we lay down the pedagogic rule, that not only shall the circular plaster splint when applied over recent fracture be split its entire length, but that every shred of circular bandage beneath shall be entirely cut through. He had seen some very unfortunate results from ischæmic contracture following the violation of this rule.

DR. SETH M. MILLIKEN remarked that, of course, the grossly open fracture with projection of the entire fragment is to be treated conservatively, usually; but so many fractures are opened by a slight puncture of the bone, making a small pin-hole in the skin. It seemed to him that those should be treated by the immediate reduction, just as the closed fracture. It is easy to get a fresh fracture back into place. After it has started, it seems to snap in anatomically. It is hard to do it the next day or after the X-ray is taken. As far as dressings are concerned, on the forearm and on the leg, the moulded splint may be accurately applied. It hardens very rapidly. There is no internal circular layer to be cut down. The only circular layers are the outside bandage, which can be cut as soon as the patient begins to complain of pain, which is very rare after they are properly reduced. After the fracture is reduced, the patient is easier and the swelling diminishes. But, with the moulded splints, if there is any continued swelling, the

bandages are easily split and the new bandage put over that without displacing the fragments or splints.

DR. CHAS. N. DOWD remarked that, whenever the question of operating for fractures in children arises, he felt like referring to the valuable work which Dr. Truesdell, of this city, has done on the subject. He has taken series of X-ray pictures of very young children who had excessive deformity after badly united fractures. The results showed a marvellous power of adjustment. Even when excessive angular deformity existed the ultimate result was almost perfect. Children have far better power of overcoming fracture deformity than adults have.

ELBOW DISLOCATION TREATED AS A FRACTURE

DR. SETH M. MILLIKEN presented a man, with a history as follows: twenty-five years old, a fireman. The engine wouldn't start on a self-starter, so he started to crank it, when he felt a kick and a severe pain in his elbow. He was seen by the ambulance surgeon, who applied a posterior splint to the arm, in complete extension, and was admitted to the division as a fracture about the elbow for X-ray. On examination, there was a perfectly obvious posterior dislocation. There was no fracture evident or to be made out. The reduction was very easy by straight traction and it snapped in with an audible click. The X-ray, subsequently made, shows no bony lesion.

He had two reasons for bringing this elbow dislocation before the Society. One was the rarity of the cause of the injury, and the other was that this is the second case within a month where a dislocated elbow has been sent in as a fracture, and in both cases splints applied. The first case had a chicken-wire, moulded splint in a child of fourteen, extending about an inch and a half below and about an inch and a half above the elbow joint. That was an external dislocation in which the head of the radius stuck out just as plainly as one's thumb.

In the case of this man, there was absolutely no injury received to any part of the arm, except that, of course, transmitted through his palm.

DR. DOWD also had had a case of dislocation of elbow this year which had been treated as a fracture, and he had great difficulty in reducing it. The dislocation had existed for five weeks when he saw it. It was impossible to reduce it without incisions, external and internal; and even then much force and the use of metal levers within the joint were necessary. There is still much limitation of motion.

BOOK REVIEW

ORAL SURGERY, A TREATISE ON THE DISEASES, INJURIES AND MALFORMATIONS OF THE MOUTH AND ASSOCIATED PARTS. By TRUMAN W. BROPHY, M.D. P. Blakiston's Son & Co., 1012 Walnut Street, Philadelphia.

THIS book of Dr. Brophy's is an encyclopædia of information concerning those subjects directly and remotely connected with oral surgery. The first sixteen chapters cover general considerations which are introduced into this book because of the need felt that the dental student should be especially well informed upon these matters. These subjects concern surgical bacteriology, special infections, syphilis, tuberculosis, the subject of immunity and serum therapy, the general subject of tumors, destructive processes, wounds, antisepsis and asepsis, hemorrhage, anæsthesia, injuries and diseases of blood-vessels, fractures and dislocations in general, diseases of bone, the examination of the blood, the surgical engine and its use in bone surgery, the latter a chapter written by Dr. Cryer, of Philadelphia.

It is of value to the dental student to have assembled in a book devoted to dental surgery these various subjects common to all surgery. If the dental student is familiar with broad principles he will the more intelligently care for his special group of diseases.

The following nine chapters deal with matters concerning the mouth and its contained anatomy, the tongue and tonsils. In these chapters fractures and dislocations of the bones of the face and lower jaw are considered, ankylosis of the temporo-mandibular articulation, and the diseases of the antrum of Highmore.

The following three chapters, covering over two hundred pages, have to do with harelip and cleft palate. No surgeon in this country is better qualified to present these particular subjects than Dr. Brophy. That which stands out in this encyclopædia as the special original communication on the part of the author are these pages devoted to harelip and cleft palate. The chapters are attractively written, are thorough in their review of the subject and leave upon the reader's mind an impression of authority which is most stimulating.

Then follow two chapters, one by Dr. Calvin S. Case, upon the mechanical treatment of congenital cleft palate, and one by Dr. G. Hudson-Makuen, upon the training of speech after cleft palate operations. This thirtieth chapter upon the training of speech after cleft

BOOK REVIEW

palate operations is most timely. It is coming to be recognized that speech training after cleft palate operations is very important. A recognition of this importance in training is shown by the fact that at the Massachusetts General Hospital recently there has been established a clinic in connection with the Throat Department for the training in speech of those upon whom cleft palate operations have been done.

The chapters which close the book have to do with the teeth, and with the transplantation of teeth, this latter being described by Dr. Win. J. Younger, of Paris, France.

Two chapters are devoted to a description of the cysts occurring in the jaws and tumors of the jaws. These two chapters upon cysts and tumors are intended to give the student a clear idea of these pathological processes.

Chapter 37 is devoted to trigeminal neuralgia, Chapter 38 to the salivary glands, Chapter 40 to prosthesis, and Chapter 41 to infant feeding, written by Dr. F. W. Belknap.

The final three chapters have to do with the ligature of arteries about the head and face, with prognathism and diseases of the lips. Then follows a well-arranged index to the book.

This book of Dr. Brophy's is a valuable contribution to the literature of Oral Surgery. The very comprehensive way in which the subject is presented is of especial value to the dental student and in general to the dental practitioner. It is obviously impossible to criticise the presentation of each of the important subjects. For the purpose of this review it seems to me sufficient to say that the book is well conceived and meets a need of the dental student. In connection with the subject of oral surgery it presents the modern conception of disease and gives the recent and good suggestions for treatment. The book is profusely illustrated, and these illustrations are helpful and attractive. However one may differ with Dr. Brophy in the methods of treatment advocated in certain conditions, the fact remains that he has contributed a most interesting book to the literature of this subject. It is a good book of reference.

CHARLES L. SCUDDER.

To Contributors and Subscribers:

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N. Y.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS of SURGERY

227-231 S. 6th Street

Philadelphia, Penna.

ANNALS *of* SURGERY

VOL. LXIII

JUNE, 1916

No. 6

THE TREATMENT OF FRACTURES BY METHODS OF SUSPENSION AND EXTENSION

BY JOSEPH MARSHALL FLINT, M.D.

OF NEW HAVEN

PROFESSOR OF SURGERY, YALE UNIVERSITY

(From Hôpital 32 bis, Chateau de Passy, Hôpital Français de New York)

COMPARED with its tragic consequences, there can be few advantages resulting from the great war. It is to be hoped, and is indeed quite certain, that the enormous surgical material provided by the wounded will yield some new methods of permanent value to civil surgery. Few problems have faced military surgeons more important than the question of infection and fractures, particularly when they are associated in combined problem like that of compound fractures. They form not only a very considerable percentage of the injuries in modern warfare, but also perhaps the greatest and most difficult single problem of the base hospital. There is nothing particularly new in the treatment of such fractures by suspension and extension, as these methods have been used for years, but the enormous material presented by the war has stimulated the interest of certain hospitals in them, resulting in a widened application of this kind of treatment which should lead to their more extensive use in civil hospitals.

To this particular field, the staff of the American Ambulance has made a conspicuous contribution and has devised many ingenious splints and appliances. To attempt much work of this character, it is first of all desirable to have a good mechanic who can make the necessary splints and adjust the apparatus according to the wishes of the surgeon and then to have a convenient framework upon which the fractured extremities can be suspended and extended. In the previous work with this method in New Haven, we have used a single frame extending from the head to the foot of the bed and giving points of support about 5 feet about its surface. In one ward we have had a removable overhead support like a joist with adjustable pulleys extending over the bed at a height of about 8 feet. This has been employed particularly for Hodgen's splints.

At the American Ambulance, suspension and extension has been applied by means of wooden frames attached to the head and foot of ordinary beds with movable supports running longitudinally to carry the pulleys.

In attempting to develop this feature of our work during my term of service at Hôpital 32 bis, Chateau de Passy, I happened, in visiting an old hospital in the adjacent town of Villeneuve, to see some of the old-fashioned four-posted *lits à baldequin*, such as were used in the Middle Ages in many French hospitals, when patients were surrounded by curtains to protect them from drafts or currents of air. In old prints of the Paris hospitals, in the periods after the Louis, such beds are not infrequently seen. Realizing their possible value for the treatment of fractures, we succeeded, through the courtesy of the Mayor of Villeneuve and the authorities of the Hotel Dieu, in exchanging for the period of war a series of our American for these old-fashioned four-posted French beds. It is interesting to know that these identical beds, M. Mayaut, the Mayor, informs me, were purchased by the Hotel Dieu of Villeneuve, more than 150 years ago. They are still in a perfect state of repair and represent to my mind the most ideal form of fracture bed which it is possible to devise. At first we were somewhat concerned lest the springs should prove to be uncomfortable, as they are formed of interlacing bands of spring steel which slope in a gently rounded curve upwards from the foot towards the head of the bed. Experience has shown, however, that not only are they comfortable, but this particular type of spring is perfect for the treatment of fractures, inasmuch as the curve compensates for the unequal weight of the trunk and extremities, so that, as the patient lies on the bed, the spring flattens out on an even plane, giving exactly the same result that is obtained by a fracture board or fracture bed, without the great discomfort. It is also of interest to observe that the latest model beds constructed by the French *Service de Santé* for their military hospitals have springs of this type.

The four-posted beds with the five iron frames that are formed around and above the patient make it, of course, a simple mechanical task to provide points of support for extension and suspension in any direction desired. As our experience with these beds has increased, we found that they were well adapted for the treatment of almost any injury of the extremities, from the simple suspension of painful arms or legs immediately after operation or injury, to increase either the comfort of the patient, or the facility with which painless dressings could be done, to the application of complicated extension appliances with many points of support for severe complicated fractures.

Perhaps the simplest method of indicating the advantages of this fracture bed would be to describe *seriatim* the types of injuries and fractures which we have found it convenient to treat by means of suspension or extension in them. This includes likewise a discussion of the splints which we employed for this purpose, where either they or the method of using them differed from those which are in vogue elsewhere. Some of the apparatus employed at the American Ambulance has already been described by Fauntleroy¹—but a complete description of their beds and splints will appear in a forthcoming book by Miss Gassette, who is in charge of this department at the Ambulance. Our beds were all equipped with adjustable transverse supports with small rings that fitted into a series of notches so that firm support could be obtained at any desired point above the patient. Extension in a horizontal direction was obtained over the foot of the bed. In all points of suspension and extension a spring was inserted to make the pull elastic and act as a shock absorber. This adds greatly to the comfort of the patient. An ordinary fish scale or helical spring serves this purpose very well. Small muslin hammocks held by wooden spreaders proved of great value for simple suspension. It is difficult, however, to standardize this equipment except in a general way, inasmuch as the cases, especially in a military hospital, tend to present particular problems, each of which must be solved on its own merits. A study of the photographs and drawings accordingly will give a much clearer idea of this part of the problem than could be obtained by mere word description.

Suspension of the Arm.—We have found a number of conditions, such as extensive lacerated wounds of the arm, resections of the elbow, etc., which are extremely painful, on account of the motion during the dressing, in which fixation and suspension can be applied with great comfort to the patient and with added convenience to the staff. Figure 1 shows a case of this type where a wire splint is made to support the arm in a case of resection of the elbow for a combined arthritis and osteomyelitis following an explosive gunshot wound of the elbow-joint. The counterweight (Fig. 1) is so accurately adjusted that the arm maintains any position in which it is placed. In this way, the dressing can be done very easily without pain or discomfort to the patient. The wire splint was snugly bandaged to the arm and above and below the field of operation, which is left exposed and covered by a second bandage. With this apparatus the weight of the extremity is lifted entirely from

¹ Fauntleroy: Report on the Medico-Military Aspects of the European War. Washington, 1915.

the bed, the position of the arm is automatically changed by movements of the patient and, at the same time, if the patient wishes to get up, the suspension apparatus can be detached and the splinted arm carried in a supporting sling. The possible variations of this method are numerous and obvious. It was found particularly satisfactory in a case of very extensive lacerations of the inner aspect of the arm reaching from a point just below the insertion of the deltoid to the middle of the forearm, in which the inner half of the elbow-joint was carried away by a shell fragment with destruction of the median and ulnar nerves and of the brachial artery. Every movement of this patient's arm was

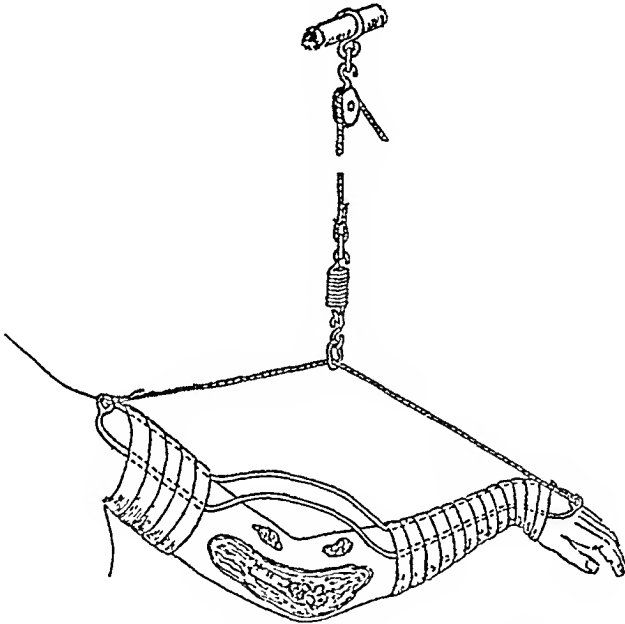


FIG. 2.—Suspension of the arm for lacerated wound about the elbow-joint, with a compound joint fracture.

exquisitely painful. The large wounds and the septic arthritis presented a problem which would have made dressings by the ordinary method so painful as to require an immediate amputation. This arm was supported by a wire splint which was bridged over the elbow-joint to afford space for the dressings and suspended with counterbalanced weights (Fig. 2). In this way, it was dressed with great comfort through a period of about two weeks until the lacerations had entirely granulated and the collateral circulation after obliteration of brachial artery was fully established. The arm was then amputated just above the elbow with atypical flaps. Had an immediate amputation been necessary it would have been performed at the level of the insertion of

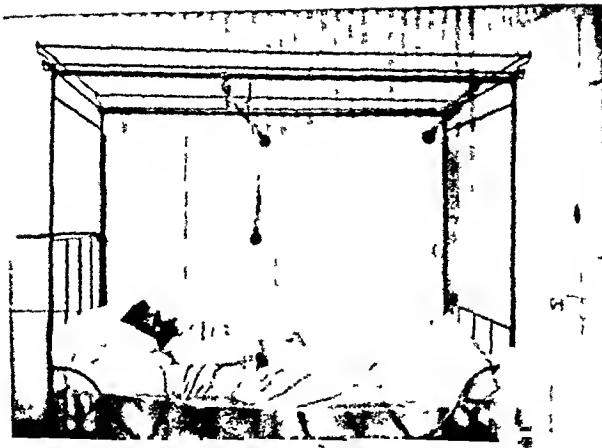


FIG. 1.—Simple suspension of the arm for resection of the elbow.

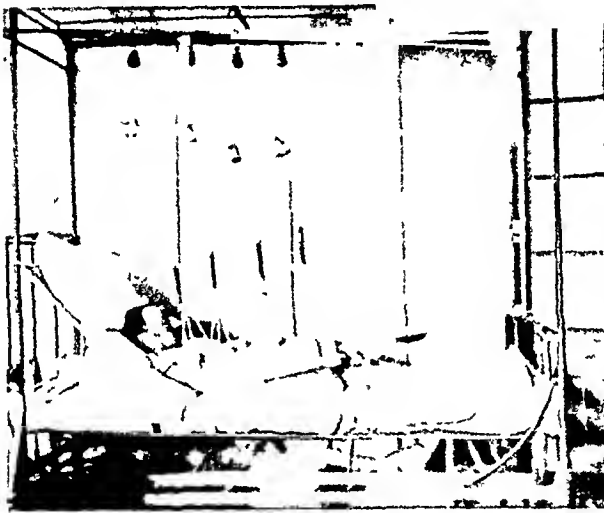


FIG. 3 —Horizontal extension and suspension for compound fracture of the middle of the humerus.

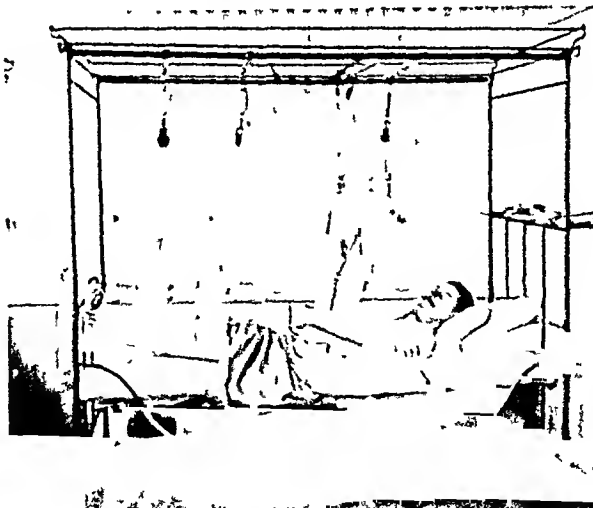


FIG. 4.—Angular extension for fracture of the humerus, suspension of the leg.

the deltoid. It is in cases like these that simple suspension is not only a great comfort to the patient, but also a great convenience to the surgeon.

Fractures of the Humerus.—Vertical extension for fractures of the humerus is very simply applied on these beds. Adhesive straps are placed on the forearm alone or over the elbow up to the site of the fracture, which are connected with the pulleys on the overhead traverse so that the counterweights are carried off to some convenient point at the side of the bed. These should be heavy enough to maintain the extension during the movements of the patient. The problem is exactly similar to the almost universally used method of vertical extension of the thigh in children.

Horizontal extension for fractures of the humerus is likewise easily applied, either through the forearm or directly to the site of the fracture. In these cases, the extension weights are carried by a pulley over the foot of the bed, giving a direct pull on the humerus. At the same time, the arm is suspended in a series of hammocks and counterbalanced by weights above the bed. To distribute the support evenly along the arm, a padded basswood splint is inserted between the arm and the supporting hammocks. By taking down one or two of the latter, compound fractures are easily exposed and dressed. The arrangement of the apparatus in a case of this type is shown in Fig. 3.

The angular method of combined suspension and extension for the treatment of fractures of the humerus as employed by the American Ambulance is shown in Fig. 4. This combination of extension and suspension is obtained by counterweighting the arm so accurately that it rises and falls perfectly without effort as the patient moves, while the extension pull running to the foot of the bed maintains the alignment of the bone. The forearm is first placed in adhesive straps attached to a spreader which, in turn, is supported by a rope that passes through two pulleys, to a counterweight at the side of the bed. The extension is obtained by two adhesive straps extending to or just above the site of the fracture. The straps run to a spreader to prevent pressure on the condyles, from which a cord carrying the extension weight passes through a pulley at the foot of the bed. In cases where it is not easy to attach adhesive straps, as in certain compound fractures, the figure-of-eight bandage may be substituted to take the pull of the extension weight. To prevent angulation at the site of fracture, the humerus itself is supported in a broad muslin hammock, which is likewise counterweighted to bear in part the weight of the arm, the pressure of which can be distributed along the whole humerus by inserting a small padded

posterior splint of basswood. This rather complicated mechanism gives beautiful results, for the patient sits up, lies down, sleeps, with complete relaxation of the arm while the fracture is maintained in excellent position. Furthermore, the dressings of compound fractures are extremely simple and quite painless, inasmuch as the entire arm may be exposed for the dressing. We have not modified the use of this method except to insert helical springs in all points of support and extension to act as shock absorbers and render the action of the apparatus more comfortable to the patient.

In the treatment of fractures at the lower end of the humerus

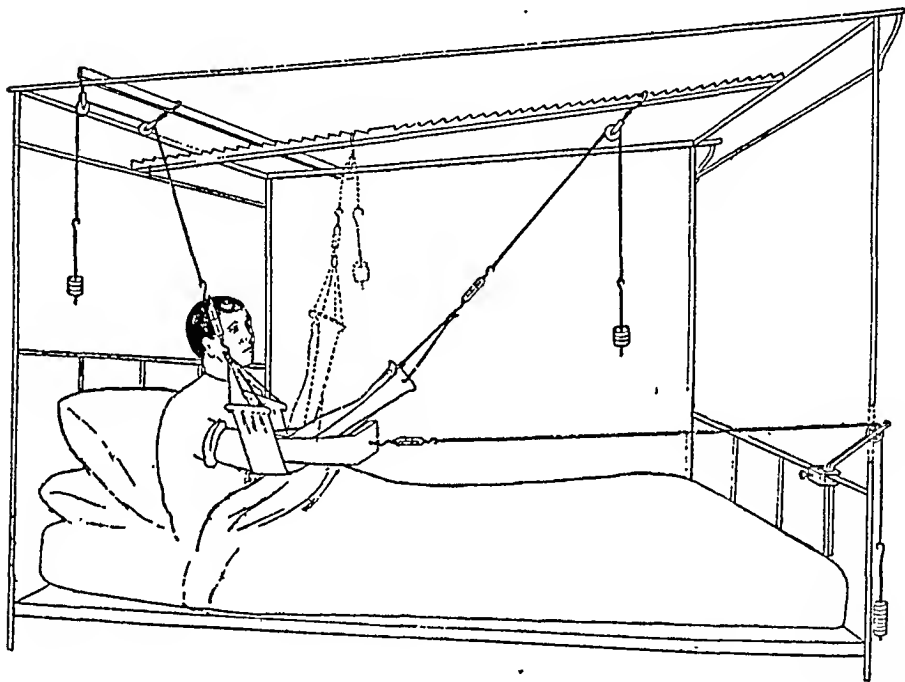


FIG. 5.—Suspension and extension for fracture of the humerus, involving the elbow-joint, with adjustable suspension of the forearm.

involving the elbow-joint, we have used a special adaptation of this method, which is shown in Fig. 5. The adjustment of the extension and suspension weights is exactly the same as in the case of fracture of the shaft, except longitudinal pull over the foot of the bed is exerted by the figure-of-eight bandage or through the forearm. The suspension cord of the forearm, instead of running to a fixed point in the overhead frame, is attached to a longitudinal bar provided with indentations, making it possible to vary this point of attachment at will. In order to prevent ankylosis of the elbow, the suspension point of the forearm is slowly changed twice or three times a day from a point near the foot

of the bed to one near the head. In this way an arc of mobility of about 140° of extension to fairly acute flexion can be maintained during the process of the healing of the fracture.

In general, the great advantages of these methods of treating fractures of the humerus over the ordinary fixation systems that are usually employed are, first of all, the convenience of doing dressings in compound fractures, a feature of paramount importance in military surgery, and, finally, the mobility of the joints which is maintained during the process of union, for the wrist and fingers can be moved in the suspension straps, the elbows by the change of the overhead point of support and the shoulder by change of posture of the patient.

Suspension of the Leg.—There are numerous injuries of the lower extremity where the comfort of the patient is greatly increased by simple suspension of the leg with an additional appliance which permits both internal and external rotation. Among such injuries may be mentioned fractures that can be maintained in good position, compound fractures requiring frequent dressings, operations for osteomyelitis, painful injuries of the soft parts, etc.

The method of suspension with rotation is shown in Fig. 6, where Cabot splints are employed to secure fixation of the leg. In applying these splints, care is taken to pad the heel and popliteal space carefully, after which the splint is fixed in position by means of muslin bandages that skip the site of the compound fracture or injury. It is usually wise to reinforce this with a starch bandage. The area to be dressed is covered with a temporary removable dressing. For this purpose, small Scultetus binders are very convenient and economical. The wound may be exposed and the inner dressings changed without moving the extremity. These binders may be used for several days before they have to be changed. The splint is then slung in two hammocks, which are kept extended by two round pieces of wood, in the ends of which are two holes fixing the supporting ropes. By means of a ring connection, a second rope is attached to one end of the hammock, which passes through a pulley on the frame above. This is then fixed to the opposite end of the hammock by a loop controlled by a tent block, making it adjustable. By means of the hammock, the leg is lifted from the surface of the bed and the patient finds that he not only can swing the foot laterally by motions at the hip-joint, but also can obtain internal and external rotation by the play of the ropes attached to the ends of the hammocks through the pulleys. The springs that join the latter to the transverse supports give a certain elasticity that prevents any jarring during the motions permitted by the apparatus. The mechanism and

degree of rotation are admirably shown by the detail photographs in Fig. 7.

We have had certain cases with compound fractures at or near the ankle-joint where the lower hammocks interfered with the removal and application of the dressings. These cases can be treated by the special form of splint shown in Fig. 8, where the extension of the sides below the foot-piece permits the support of the lower rotation ropes without the use of a hammock. The region of the ankle may thus be dressed without disturbing the suspension at all. In some cases where the condition requires prolonged suspension, the heel is apt to get sore. This may be prevented by the use of a suspension weight of about one pound attached to the foot by means of plantar and dorsal adhesive

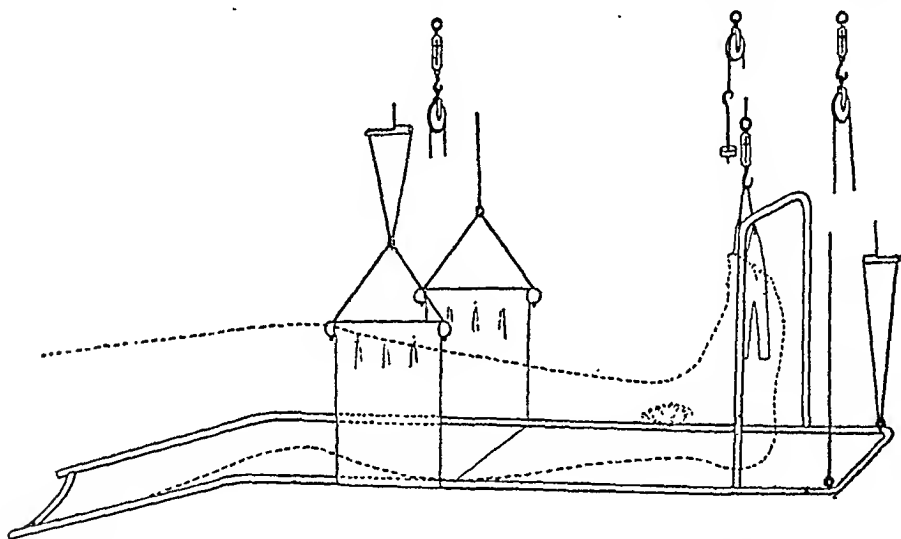


FIG. 8.—Modified Cabot splint for suspension and rotation of the ankle.

straps. This trifling weight is apparently sufficient to relieve the heel of painful pressure. The application of this counterweight is shown in Fig. 8. It is a little short of astonishing to observe how a painful extremity or a compound fracture, after being fixed upon a Cabot splint or upon a round gutter splint, may be made perfectly comfortable in a few moments by suspension in this apparatus, which allows free motion of the hip and particularly permits the patient to sleep on either side, owing to the power of rotation. The patient soon learns to adjust the tent blocks himself, which permits him to raise or lower the legs at will, and this gives the added comfort of another postural change besides the rotation. This type of treatment applies to wounds or injuries of the soft parts, osteomyelitis, simple fractures which are in good position, or fractures of one bone of the leg in which the other acts as a splint,



FIG. 6.—Apparatus for suspension and rotation of the leg.

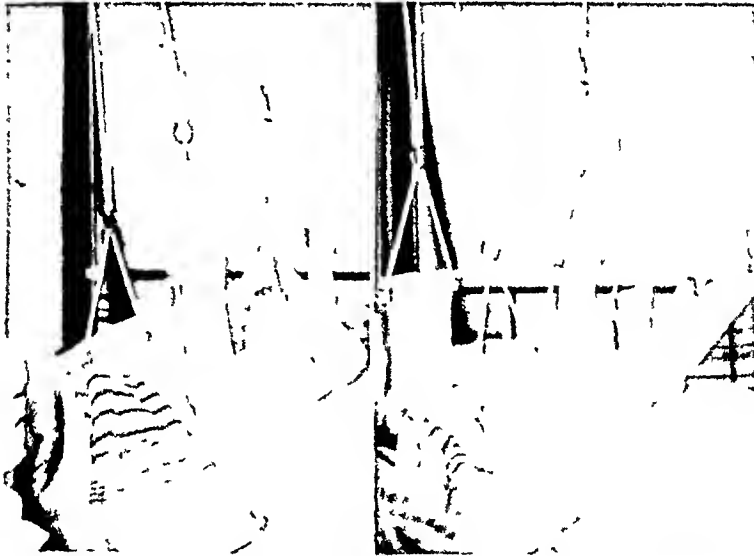


FIG. 7.—Detailed photograph showing the operation of the rotating mechanism.



FIG. 9.—Railway splint with self-contained extension appliance for fractures of the leg.

but not for fractures requiring extension. By simply slipping the hammocks off the splint, the patient can be transferred to a wheel-chair, and resuspended on his return to bed.

Fractures of the Tibia and Fibula Requiring Extension.—After having found that the patients had so much comfort in the simple suspension of the leg, an attempt was made to devise a splint which not only would permit of suspension and rotation with free movement at the foot, but would also have a self-contained extension apparatus at the same time. A splint of this type is shown in Fig. 9 upon a patient

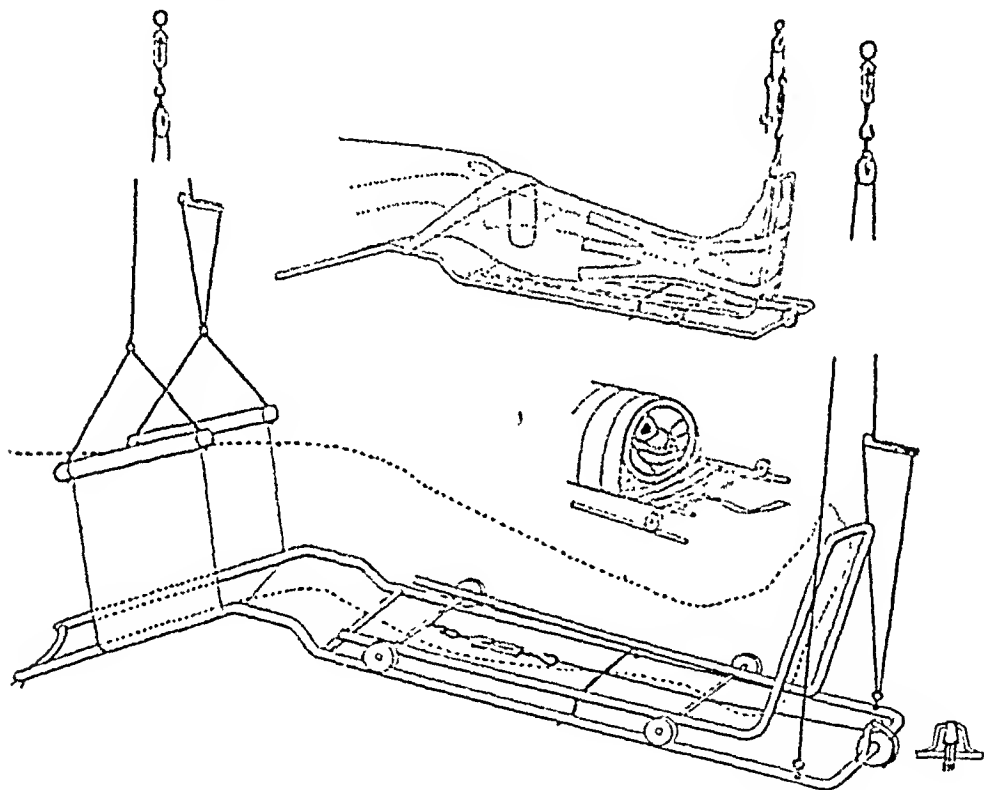


FIG. 10.—Details of the construction and application of the railway splint.

suffering from severely comminuted fractures of both bones of the leg with a gas bacillus infection in which the operation for better drainage of the infection had necessitated the removal of numerous loose fragments of bone.

This appliance was named by the patients the railway splint, because the foot and portion of the leg containing the lower fragment are carried upon a small carriage which runs upon the main part of the supporting splint as a track. The details of the apparatus are better shown in the line drawing (Fig. 10), together with the method of its application and support.

The carriage is covered like an ordinary Cabot splint. This is

padded and the foot is bandaged to the carriage, around the base of which the extension straps are joined, care being taken to protect the malleoli from pressure. The carriage should extend to a point just above the fracture. It is then placed upon the tracks of the main part of the splint, which is adjusted with a slight bend at the knee and which, in turn, is bandaged and padded at the knee like an ordinary Cabot. Adhesive straps for counter-traction are placed at convenient points near the ends of the upper fragments and attached to the side of splint. The entire splint is then suspended, either according to the method shown in the photograph (Fig. 9), in case rotation is not desired, or like that in the drawing, if the leg is to be allowed to rotate during the extension. The patients were allowed to have this detail arranged according to their own desires. The extension is exerted by a cord attached to the carriage through a spring. This is wound up on a ratchet-wheel at the foot of the splint. In making this attachment of the extension cord, a fish scale is much preferred to an ordinary helical spring, owing to the fact that a rough idea of the pull used in the extension may be determined by the readings of the scale. In some cases the two-point support is changed to a single-point, with a pulley, so that the patient himself, by adjusting the tent block, can vary the position of the splint in the longitudinal direction, as is shown in Fig. 9. When desired, the splint may be detached from the suspension bed and the patient allowed to go about in a wheel-chair, the self-contained extension operating very well under these circumstances.

Another type of combined suspension and extension apparatus is shown in the patient at the right in Fig. 11 and in the detailed drawing in Fig. 12. In this case, the patient was shot directly through the leg, with a wound of entrance on the anterior surface and a wound of exit in the calf behind. Both bones were badly comminuted and the fracture was infected with gas bacillus. The drainage was largely through the posterior wound.

In order to obtain a form of splint which would permit the dressing in this case, without motions at the site of the fracture, the leg was put up in a Hodgen's splint with a single point of suspension. Extension is obtained by means of two cords attached to adhesive straps on either side of the leg at the level of the lower fragment, that pass through pulleys at the foot of the splint, as is shown in Fig. 12. A helical spring inserted in this cord gives a constant elastic tension. Counter-traction is obtained by adhesive straps at the level of the upper fragments, which are attached to the sides of the splint. In this way the leg is comfortably suspended from the bed so that the dressings could be done without

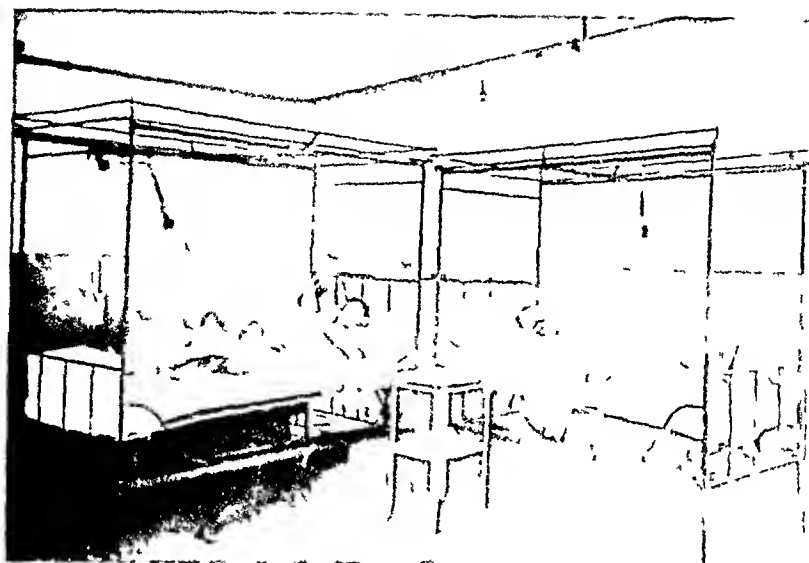


FIG. 12. —At the right, Hodgen's splint with self-contained extension appliance for fractures of the leg. At the left, Hodgen's splint for fracture of the femur with overhead inclined trolley.

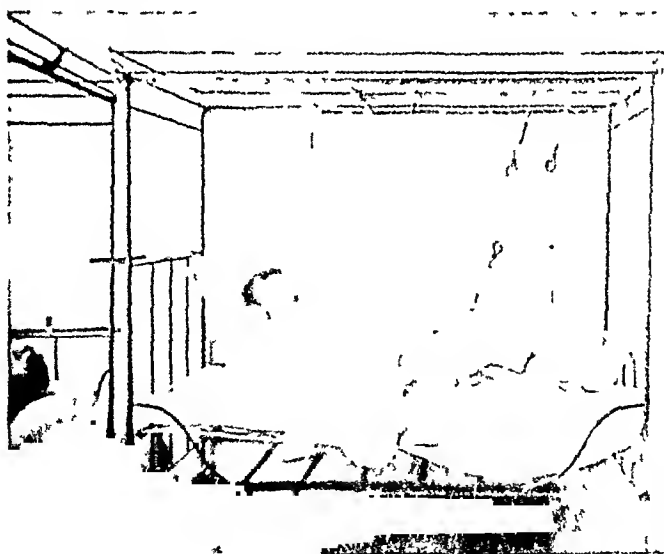


FIG. 13. —Hodgen's splint with overhead trolley for fracture of the femur.

moving the fracture, but at the same time a constant extension was applied during the process of healing. This proved to be an extremely comfortable and convenient appliance. A stirrup is applied to prevent a toe-drop.

Fractures of the Femur.—Fractures of the femur below the level of the trochanters are conveniently treated by the Hodgen's splint. The adjustment of these splints is shown in the patient at the left in Fig. 11. The combination of suspension and extension for these splints is arranged by means of an inclined overhead trolley, with the inclination towards the foot of the bed to facilitate the action of the extension weights. This allows the patient a considerable amount of mobility, but

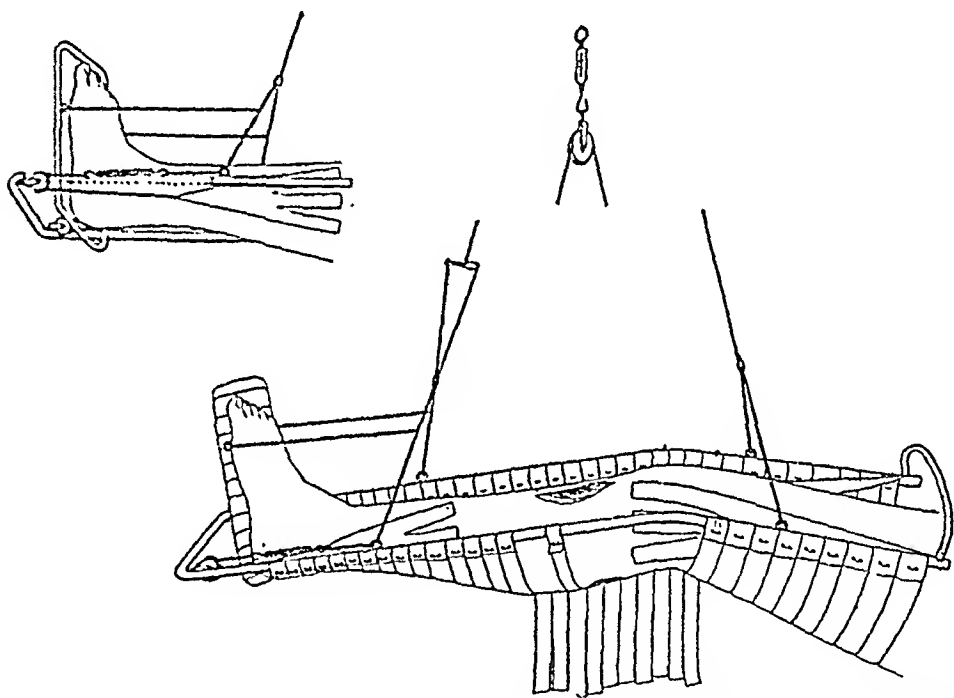


FIG. 12.—Details of the Hodgen's splint with self-contained extension for fractures of the leg.

at the same time exerts a constant extension upon the fracture. Dressings of compound fractures are easily done in the Hodgen's splint. In most cases not more than ten pounds of extension is required to hold the fracture in good position. An earlier arrangement of this method is shown in Fig. 13, which, however, is not as convenient as the inclined trolley. Another variation is shown in Fig. 14, where the splint, equipped with a foot-piece to prevent toe-drop, is elevated from the bed in a two-point fixed suspension. By this method, the extension is applied directly over the foot of the bed from the extension straps at the side of the leg. While it is quite efficient, the apparatus, however, is not as comfortable as the trolley system outlined above, owing to the

fact that the foot is fixed by the extension card, thus limiting to a greater extent the mobility of the patient. With the trolley system of suspension and extension to a common point above, the foot springs free, and adds greatly to the comfort of the patient.

Supracondylar Fractures of the Femur.—These fractures may be treated by a railway splint, the carriage of which extends to the level of the lower fragment above the knee, the portion of the splint containing the track reaching up to the pudendal fold. Counter-traction anteriorly may be made in these cases to counteract the tendency of the lower fragment to posterior dislocation by means of a hammock which

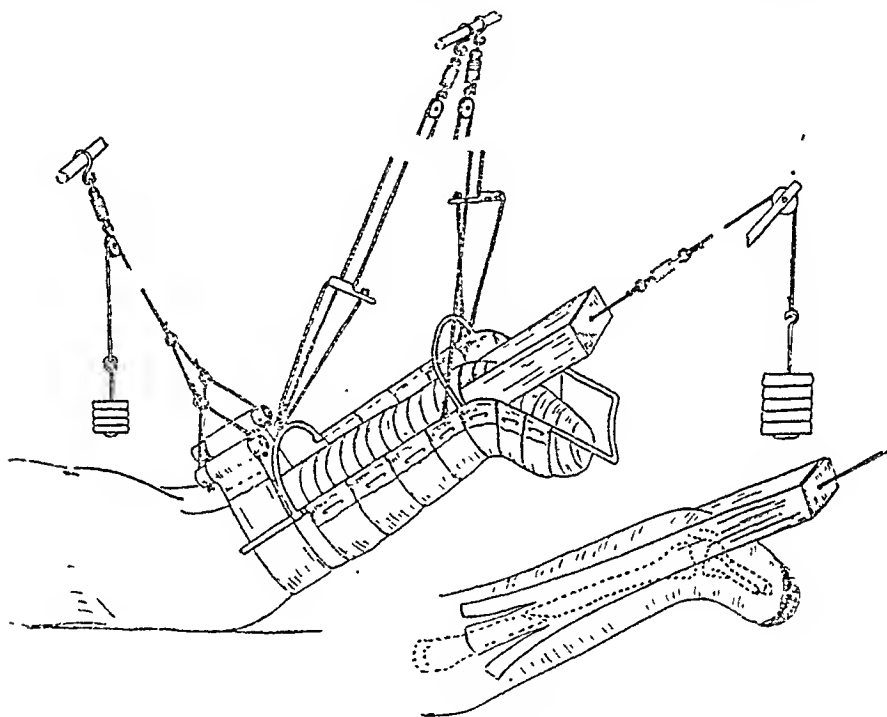


FIG. 16.—Suspended right-angled splint for fracture of the femur and open amputation of the leg.

runs to a special point of support above the bed. Another satisfactory method of treatment is shown in Fig. 15, where the suspension and extension of the leg and lower fragment are obtained by means of Cabot splint swung in hammocks to an overhead trolley, the major part of the extension being obtained directly from the leg over the foot of the bed, aided by the slight pull on the trolley system above. The upward counter-traction on the lower fragment is excellently shown in this photograph.

There are occasionally special fractures of the femur which require specially constructed splints. Such an instance is shown in Fig. 16,

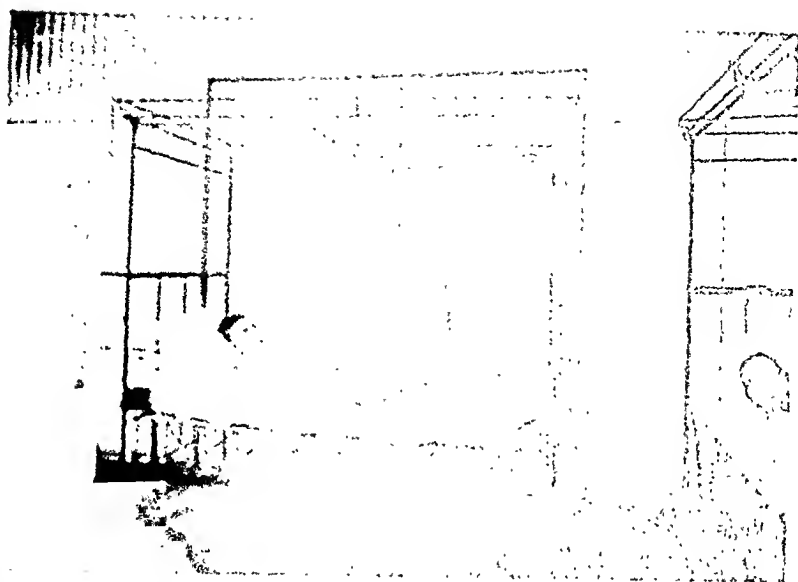


FIG. 14.—Colles's splint with vertical bar.

Close fly from the foot.



FIG. 15.—Method of extension and suspension for supracondylar fracture of the femur.

where the patient had a badly compounded fracture of the leg, necessitating immediate amputation, together with a comminuted fracture at the junction of the middle and upper thirds of the femur. This was suspended in a right-angled splint, permitting the dressing of the open amputation below, while the suspension elevated the lower fragment of the femur in alignment with the upper to overcome the pull of the iliopsoas muscle. The extension was applied by means of adhesive straps in direct line with the femur, according to the principle used in the Steinmann nail extension. Nail extension, however, could not be employed in this case, owing to abrasions about the knee, which rendered probable an infection of the femur. It is questionable whether the Steinmann nail extension has any advantage over the method of treating fractures of the shaft of the femur by means of the right-angled suspension splint, if we exclude the group where operation is indicated for malposition and shortening after union has occurred. The counter-traction exerted by the hammock in this case was to prevent angulation at the level of the fracture, when, owing to the abraded condition of the skin, the extension was reduced immediately after the formation of the soft callus.

Fractures of the Trochanters and the Neck of the Femur.—The same criticism which applies to Buck's extension in the fractures of the shaft applies also to this method in the treatment of fractures of the upper end of the femur. Mechanically it is ineffective, inasmuch as most of the weight which is applied to the extension straps is lost in the friction of the leg over the mattress and never reaches the site of the fracture. The use of heavy weights on the extension straps leads to frequent abrasions of the skin and often to effusions into the knee-joint. Some method of fixation must also be employed to correct the tendency to eversion. This lost force can be eliminated and the same result obtained by the combination of suspension and extension through the use of a long Cabot splint reaching to the pudendal fold, which simply elevates the leg for a short distance from the bed. The extension can then be obtained directly over the foot of the bed, as is shown in the accompanying sketch (Fig. 17). In this way, not only is the loss by friction eliminated, but this very factor is utilized to reduce the pull which is exerted directly upon the skin through the extension straps. In these cases the supporting bandage which holds the leg in the splint, as well as the weight of the leg itself, likewise plays a part in the distribution of the extension weight to the site of fracture. The Hodgen's splint with the free foot is not a desirable method of treating the fractures of the neck, owing to the fact that it permits too much motion at the site of the fracture. The Hodgen's adjusted with foot extension,

as shown in Fig. 14, or the long Cabot, immobilizes at the hip just as well as Buck's, but directs the extension pull more efficiently to the site of fracture, owing to the elimination of the friction. In my experience, results which were previously obtained by the application of twenty to twenty-five pounds in a Buck's extension can be given by an application of eight to twelve pounds by means of the Hodgen's or the long Cabot splint with foot extension.

There are occasionally atypical fractures for which these suspension and extension methods are particularly suitable. One such instance entered the hospital at Passy with a compound comminuted intertro-

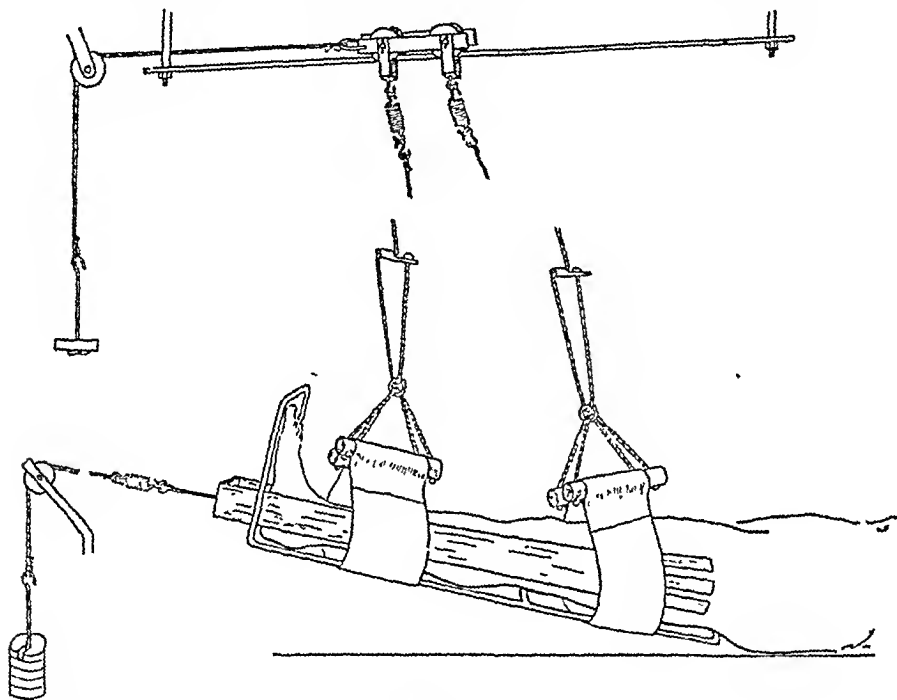


FIG. 17.—Method of applying a long Cabot splint as a substitute for Buck's extension.

chanteric fracture of the femur. Either the German ball or a fragment of bone had occluded the femoral artery, resulting in gangrene of the leg, extending to a point about 10 cm. above the knee. Inasmuch as exarticulation at the hip yields such bad results from the standpoint of the application of an artificial leg, it was thought desirable to make an effort to save the upper two-thirds of the thigh, to which the artificial limb could be more easily adjusted. Accordingly, a circular amputation was done just above the line of demarcation. The projecting end of the femur was perforated and a wire passed through it, to which extension could be applied over the foot of the bed. The stump was supported in a counterweighted hammock, facilitating the dressing of the amputation

and the wound of entrance just behind the great trochanter in the lateral aspect of the buttock. Fig. 18 shows the application of this type of apparatus. The extension in this case is applied directly to the bone, as in the case of the Steinmann nail extension. This patient was extremely comfortable, could be dressed easily, and healed with great rapidity. There was, however, a persistent osteomyelitis of the upper

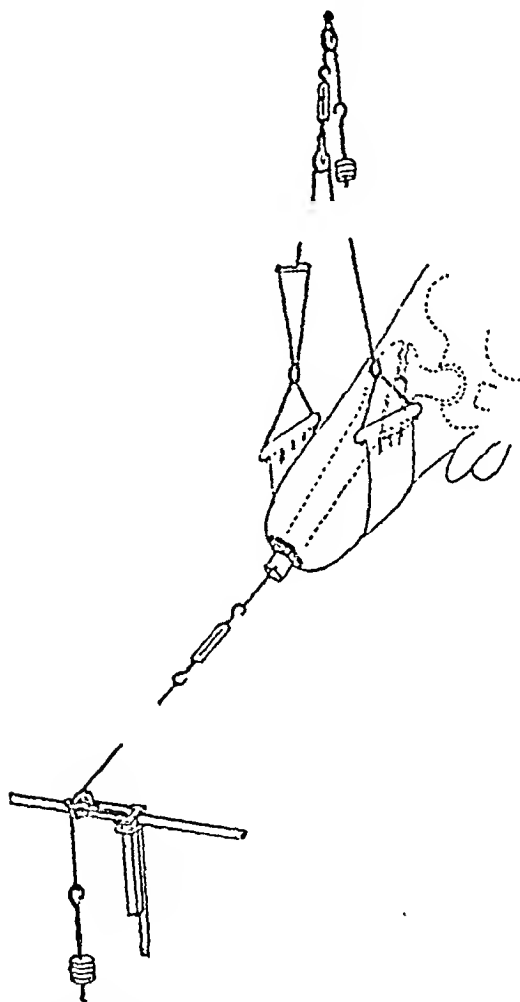


FIG. 18.—Suspension and bone extension for a compound comminuted intertrochanteric fracture of the femur with amputation at the junction of the middle and lower thirds of the thigh for gangrene.

end of the femur and a very abundant callus at the time I left the hospital.

Further study and experience with these methods of suspension and extension are sure to lead to technical improvements and a wider application of the principles involved. It has seemed, at this time, worthwhile to record our experience with the fractures thus treated, particularly to emphasize the convenience of the mediæval bed, a copy of which we hope will soon be placed on the American market.

FOREIGN BODIES IN THE RESPIRATORY TRACT*

BY NATHAN W. GREEN, M.D.

ATTENDING SURGEON TO THE CITY HOSPITAL; ASSISTANT ATTENDING SURGEON TO ST. LUKE'S HOSPITAL

AND

LEON T. LEWALD, M.D.

OF NEW YORK

DIRECTOR OF THE EDWARD N. GIBBS MEMORIAL X-RAY LABORATORY AND OF THE RÖNTGEN DEPARTMENT OF ST. LUKE'S HOSPITAL

WHENEVER a condition has been shown to be amenable to successful treatment, although that condition has long been recognized as a distinct pathological entity, it receives renewed attention from the part of profession most in contact with it particularly, and from the profession in general, later on.

This has been shown to be the case with one abdominal condition after another—too numerous to mention—and has been observed in other regions, particularly the chest and its organs of approach.

This evening we are concerning ourselves with foreign bodies in the larynx, the trachea, the bronchi and the terminal mechanism for the interchange of oxygen, viz., the lungs.

These objects all at one time or another have connection with the air current and act differently in the tissues from bodies which are buried completely. Any tendency to encapsulation means encapsulation with an opening at one or more points; and this capsule forms more the wall of a cavity in which the body lies free and in the midst of pus which is evacuated from time to time, than a true encapsulation.

History.—Going a little into the history of this class of cases it appears that the surgical attack of foreign bodies in the upper air passage dates back as far as Hippocrates who devised catheterism or intubation of the larynx in order to relieve the suffocation. Poulet¹ says the idea of opening directly into the passages was first advanced by a "Roman physician named Asclepiades, who had no opportunity of putting it into practice and was long exposed to the raillery of his contemporaries and successors."

Transverse section between two rings of the trachea was proposed by Antylus, Oribasis, Aetius and Paul of Egina, because of the then current idea of the impossibility of the recovery of divided cartilages.

Habicot prior to 1824 pointed out the way toward the rational employment of bronchotomy in cases of foreign bodies.

* Read before the New York Surgical Society, February 9, 1916.

According to Brünings and Howarth,² "the systematic examination and treatment of the trachea and bronchi by the peroral introduction of straight tubes was initiated by Killian in 1896. After being successfully applied in a case of a foreign body lodged in the bronchi it was recommended in 1897 as a clinical method."

The names of Killian, Von Eicken, Brünings, Chevalier Jackson, Mosher, Ingalls, Yankauer and many others are all familiar in connection with this subject.

Many of these investigators are laryngologists. But it is from the general surgical stand-point that we are interested in this subject this evening.

Anatomy.—In the laryngeal portion of the respiratory tract the vocal bands constrict the lumen. Between the false cords above and the vocal bands is the ventricle of the larynx. In this recess an object often finds lodgement.

The next stopping place is at the level of the cricoid where the lower end of a pin or an elongated nut meat may become caught; as in two cases of ours.

Having passed the upper part of the respiratory tract the next point of arrest will be at the bifurcation of the trachea, if the body is too large to pass into one of the main bronchi. This site rarely arrests the object, however, as bodies small enough to pass the cords will slip into the bronchus. The right bronchus from its large size and the position of its opening is the one most frequently entered (Fig. 2). The spur dividing the two bronchi is situated to the left of the median line of the trachea and serves to direct a rapidly moving object into the right bronchus.

Less frequently it may pass into the left main bronchus. When the body has passed into either main bronchus its next point of arrest is either in the eparterial bronchus on the right or the hyparterial bronchus on the left or in the "trunk bronchus" on either side. The latter is fortunately the more frequent place. The trunk bronchus may be called the continuation of the right or left main bronchus after giving off the branches to the upper lobes.

A smaller body may penetrate to the divisions of the "trunk bronchi," the various lobe bronchi, and their subdivisions.

Classification of Foreign Bodies.—The foreign bodies found in the respiratory tract may be divided according to their composition into mineral and metal and organic objects.

Most of the mineral or metal objects on account of their density are impervious in a greater or less degree to the Röntgen rays.

Of the organic objects those which have a certain percentage of calcium or other heavy salts are detected by the X-ray (pieces of bone and teeth).

Again, foreign bodies may be divided according to their shape into round, elongated, irregular and sharp-cornered.

The most to be dreaded are the organic objects which are round and smooth and can swell rapidly,³ such as seeds and beans, and those which break up easily, such as nut meats. Pieces of bone and pieces of tissue are also to be placed in the dangerous class. By far the most easily recovered ones are the metallic bodies.

The most frequent occurrence of foreign bodies in the air passages is with children. Brünings says 69 per cent. of foreign bodies occur in children up to twelve years of age. The greatest frequency is at about the age of two years.

All of our personal cases have occurred in children, except one, that of the soldier who inhaled a badge fastener at the age of seventeen years and in whose lung it remained for six years (Fig. 3).

So this particular disorder may be called a disease of childhood and youth.

Case of F. S.,* twenty-four years of age. Patient was admitted to the medical service of St. Luke's Hospital under Dr. Austin W. Hollis, suffering from cough and with a foul expectoration. Seven years ago he had a thoracotomy done in London for what appeared to be an empyema. The wound healed in five or six weeks and there has been no discharge since. The week previous to his admission he expectorated large amounts of foul-smelling pus, although coughing no more than usual. The sputum was greenish-yellow and there was never any blood in it. In short, he gave a clinical picture of a patient suffering from bronchiectasis.

On January 30 he was radiographed by Dr. Truesdale, and this showed the presence of a foreign body. On January 31 and on three later days he was radiographed by Dr. L. T. LeWald, who confirmed the diagnosis of a foreign body, and, by taking exposures at right angles, showed the true nature of the object, namely, that it was much the nature of a cotter pin. On going over the anamnesis, it was brought out that seven years before he had "swallowed" a badge fastener which he thinks he was holding in his mouth when a comrade slapped him on the back. (The badge fastener was used to fasten the regimental badge to his uniform.)

* This case was presented before the New York Surgical Society, April 28, 1915, and was reported in the October, 1915, number of the ANNALS OF SURGERY.



FIG. 1.—Röntgenogram of bronchial tree of female child, nineteen months of age. Bismuth mixture injected through bronchoscope. Consolidation of right lung prevented complete injection. (Lynah and LeWald.)



FIG. 4.—H. G. Fish bone lodged in trachea. The shadow corresponds in size to the bone which was expelled through the tracheotomy tube.

RIGHT

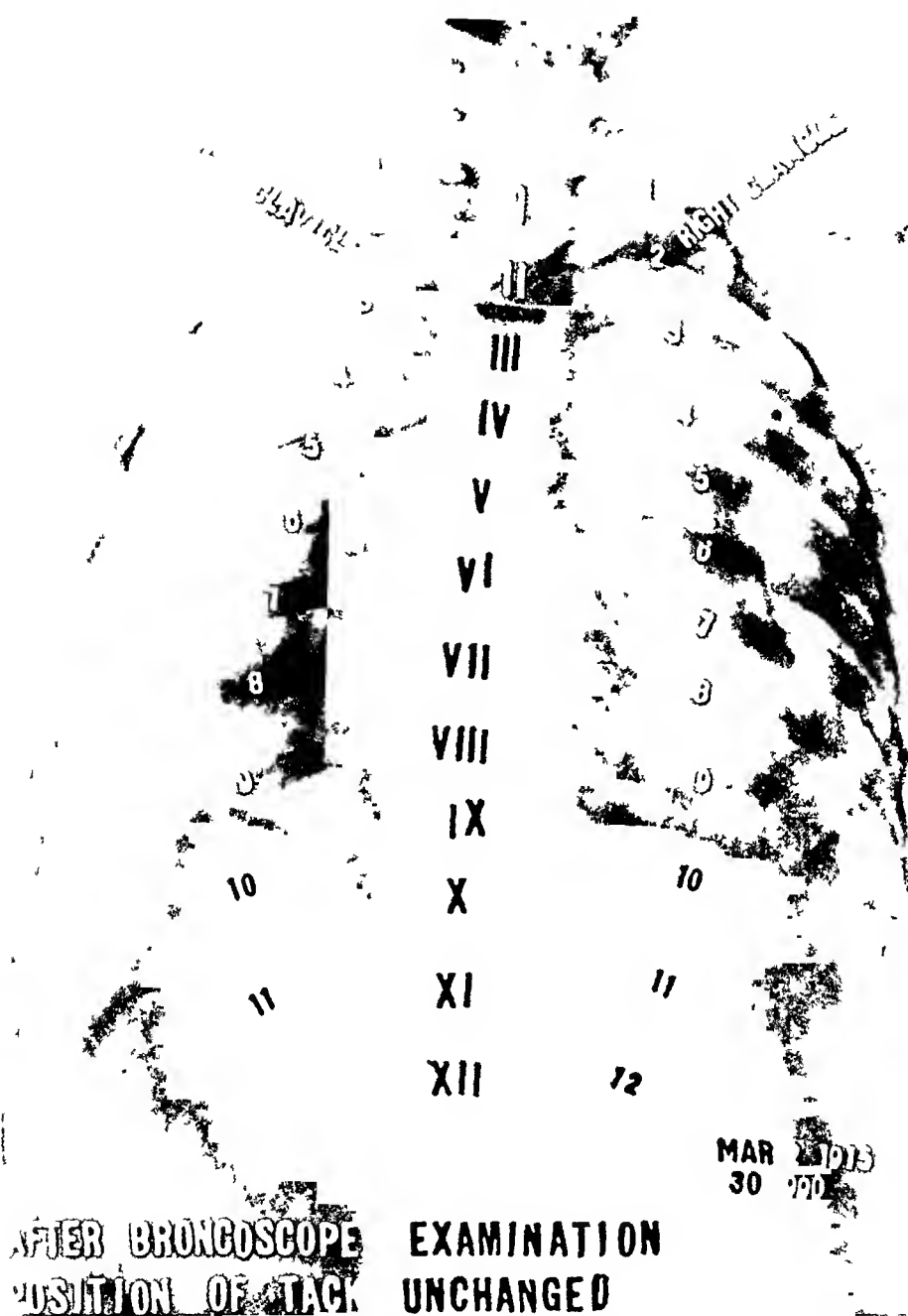


FIG. 5.—Röntgenogram of chest of F. B., showing foreign body, tack, in abscess cavity communicating with right bronchus, after an attempt had been made to reach it orally. It was later removed by a lower bronchoscopy.

FOREIGN BODIES IN THE RESPIRATORY TRACT

He was transferred to the surgical service March 20, 1915. Repeated attempts to find the foreign body were made by upper bronchoscopy, and, although the object could not be seen, in one of these attempts, the presence of a cavity was demonstrated, and in coöperation with Dr. Le Wald, the nearness of the end of the bronchoscope to the foreign body was shown. Later this helped to locate the pin by measurements and by the X-ray. On March 29 the bronchoscope was introduced and the magnet introduced through it, with the hope that the foreign body might be of iron; then the radiograph was taken. This showed the magnet to be within an inch of the foreign body, but there seemed to be no tendency to attract it. It was decided then that it would be better to go in through the back and remove it in this way.

On April 1 three shot were placed on the skin as a marker and a piece of half-inch-mesh wire netting. Radiographs were then taken by Dr. LeWald in two directions. The distance of the foreign body was measured and found to be in one direction 6 cm. from the shot and lying just in front of the rib.

Operation (April 1, 1915).—Under local anæsthesia, two ribs were removed by Dr. Green. The lung was found adherent to the parietal pleura, as was expected, and found to have a hard spot in it. At the suggestion of Dr. Martin this hard spot was entered with a needle and found to be the wall of a cavity. The needle was followed with a pair of dissecting scissors and upon opening them the cavity was widely opened. A pair of Blake's gall-stone forceps was then introduced into the cavity and the foreign body grasped and brought out. A tube was then placed into the lung and the wound was partially closed, leaving drainage.

The interesting points are that the X-ray located the badge fastener; repeated attempts to see the object through the bronchoscope failed, but the bronchoscopic method furnished the following information: That there was something causing granulations which filled up the right terminal bronchus. Second, that there was a cavity at the end of the right terminal bronchus, $2\frac{1}{2}$ inches in length. (This was proved by passing a probe through this scope and feeling it "give" as it passed the opening of the cavity.) Therefore, the foreign body probably lay loose in this cavity. Third, that the foreign body lay well toward the base of the lung, behind, and just anterior to the rib. Fourth, that the most of the cavity was rather behind the bronchus than just at the end of it.

The convalescence has been rapid although not complete. The character and odor and quantity of the sputum have changed markedly for the better, and the patient looks the picture of health. —

It has been impossible further to report on this case, as the

patient while crossing to England on the Lusitania was drowned at sea.

Classification of Cases.—The reaction of the organism to the various foreign bodies differs with the length of time of lodgement.

Recently inhaled bodies produce at first but little reaction beside that of reflex coughing and dyspnoea. This class of cases may be termed the immediate cases.

Patients in whose lungs the foreign body has found lodgement for a longer time present the complications which make their condition that of extreme severity. They may be classed as deferred cases.

This differentiation in the cases is important throughout the whole tract, but nowhere as important as in the deeper structure of the lung, where the late manifestations may be those of infection, either acute and local, or more chronic, with the changes in the general system due to absorption.

The Means of Diagnosis.—The first point in making a diagnosis is the history. This is often of an indefinite nature, especially in cases of long standing, and the essential points may be forgotten until the later symptoms may lead one to suspect the presence of a foreign object, when one again goes over the history with the patient's family (as is illustrated in the case of F. B.).

Case of F. B.* Patient was admitted to the surgical service of St. Luke's Hospital, special to Dr. William A. Downes, on December 16, 1914, suffering from a cough and fever. He was then six years of age. One month prior to his admission he began to cough, but was not ill enough to go to bed. His cough continued and grew worse, and five days before admission he grew markedly worse. He had lost weight and complained of pain in the right chest. Upon admission, he gave the signs and symptoms of a right empyema, for which he was operated upon immediately. As his condition did not clear up in the usual time, he was radiographed by Dr. Le Wald and the presence of an upholstery tack in the region of the right terminal bronchus was discovered as the cause of the delayed convalescence. Upon questioning the father more closely, it was recalled that the child "swallowed" a tack two years previously, but this had been forgotten. He was turned over to Dr. Green for bronchoscopic examination and for removal of the foreign body, if possible.

The physical findings at that time were dulness over the right chest posteriorly from the angle of the scapula to the base, with diminished voice and breath sounds and numerous large, moist râles. An attempt was first made by means of an electromagnet,

introduced into the persisting sinus in the right chest, to draw out the tack, but this failed. Repeated bronchoscopic examinations through the larynx showed granulations at the end of the right bronchus with pus exuding. The cavity which proved later to be surrounding the tack was not entered at this time. A tracheotomy was performed on March 2, and seven days later the boy was bronchoscoped through the tracheotomy wound. At this time the bronchoscope passed nearly to the cavity and forceps could be pushed into the cavity for two inches.

It was considered that part of the tack at least must be made of iron and so a small electromagnet, which passed through the smallest size of bronchoscopic tube, was made, and this was introduced through the tube ten days later, under combined ether and cocaine anæsthesia. The tack was mobilized by this means and brought up into the end of the bronchoscopic tube with the head of the tack across lumen of the tube. An attempt to grasp it failed and the procedure was then at once repeated. This time it brought the point of the tack into the bronchoscopic tube. It was then grasped by special forceps through the tube and, resistance to its removal being felt, a steady traction was made upon it as the child breathed, and little by little the resistance was overcome and the bronchoscope and the forceps through it grasping the tack were removed simultaneously. There was some bleeding from the granulations. A suction tube was at once introduced to remove this, and in a moment the bleeding stopped.

The child since then has been steadily improving. The character of the expectoration which at first was fetid and green has changed to a white expectoration without odor. The amount of expectoration has diminished as well as the amount of drainage through the chest. The child is gaining flesh.

The interesting points in the case are that the foreign body had remained in the lung for two years and that there was no attempt at encapsulation. It lay in a cavity in the lung at the end of the right terminal bronchus and this cavity contained about an ounce of pus.

The later history of F. B. showed his health greatly improved while the side was open and draining, but with loss of flesh and color when it closed. The expectoration also again became foul and thick and reverted toward his previous condition, before removal of the foreign body.

He was readmitted to the hospital, August 3, 1915, and on August 20, 1915, a thoracoplasty with excision of the seventh and eighth ribs, under combined general and local anæsthesia, was performed. The pathological findings at this time were as follows: There was a sinus tract leading from a scar in the skin through the

seventh rib. The seventh rib had a large spur attaching it firmly to the sixth rib. The sinus tract led down to the dome of the diaphragm and also apparently connected with the bronchus. The pleura was but imperfectly adherent to the chest wall and the pleural cavity was opened at this time but was closed by suture.

On December 28 the external wound was again healed.

This condition of affairs is more apt to obtain when the object has found lodgement in the smaller bronchi and there has become fastened with no further displacement. An object which remains in such a position after the initial symptoms of severe cough and varying dyspnoea may give rise to comparatively little disturbance until some of the deferred phenomena have begun to show themselves.

On the other hand, an object which remains stationary in the larynx or trachea will probably give rise to more or less constant symptoms, especially those of dyspnoea, either from occlusion of the air interchange or due to a continuous reflex inhibition of respiratory movements. "If the interference with the entrance of air is not great the foreign body will be tolerated and particularly if fixed give but few symptoms."⁴

Again, if an object has been arrested at the tracheal bifurcation or in the right or left main bronchus, it may be of such proportions that it is neither impacted nor coughed out, but acts as a movable body, which may be blown about by the current of air and find impingement upon different parts of the mucous membrane, each time causing a fresh paroxysm of coughing.

Finally, any symptom for which the cause is obscure must, among other things, be considered as possibly due to a foreign body. The presence of a localized bronchitis, a pneumonia which fails properly to resolve, a lung abscess, a bronchiectasis, or a chronic empyema should lead our attention to the possibility of the complication of a foreign body and one should at once proceed to a further means to clear up the diagnosis.

The most important next step should be to have the patient submitted to a röntgenologic examination. This is important in immediate cases and also in those of the deferred type.

Chevalier Jackson has said that it is his belief that almost all kinds of foreign bodies can be detected by a properly taken röntgenogram.⁵ This is in a large measure true; but it has been our experience that such a radiograph may not give strong enough proof in itself of the existence of an extraneous object (Fig. 4), but may be of assistance in suggesting the location of the foreign body and become a record when one has finally recovered the object.

It is difficult to conceive how a seed or a nut meat in the bronchus can be of sufficient density to betray, in the immediate cases, its location.

After the Röntgen-ray and of equal importance, but secondary in sequence from a diagnostic stand-point, comes the direct inspection of the larynx, trachea and bronchi by means of the bronchoscope. One is fully aware that he may have laid himself open to criticism in placing this procedure second in point of time to the röntgenologic examination, but the reasons for doing so are the following:

First, the Röntgen-ray examination requires but little time.

Second, it may be done without an anæsthetic (which in some cases is necessary).

Third, it is of no discomfort to the patient.

Fourth, it may materially shorten the following bronchoscopy by giving the operator a distinct indication of the portion of the bronchial tree or entire respiratory tract to be investigated.

All these indications may be altered in certain cases and the examiner who is familiar with bronchoscopic work is the best judge in each particular case as to which shall precede the other.

Treatment.—In the matter of treatment of these cases, Garré and Quincke say: "When we consider the not infrequent unfortunate consequences of foreign bodies which have not been removed (hæmoptyses) and the most unfavorable prognosis of operations on the secondary pulmonary suppurations caused by them, the necessity of an earlier active therapy needs no stronger argument." ⁶

With them it is one's privilege to agree as also with Von Eicken, who says: "Whilst in earlier statistics the mortality in cases of aspiration of foreign bodies showed a terribly high percentage, at the present time it is an exception for anyone to die from such a calamity if suitable treatment is available." ⁷

The treatment of the immediate cases and of the deferred cases differs markedly, both as to procedure and as to the ultimate outcome. An immediate case which is treated unsuccessfully at the first sitting, or if necessary sittings, becomes then a deferred case and passes at once into the category of serious illnesses.

It is not the purpose of this paper to go into the minute and tedious details of bronchoscopic technic, but rather to indicate what in our opinion are the salient points of the bronchoscopic procedure, which entails, to a large degree, the sum of immediate treatment.

In the immediate cases the object of the treatment is to get at the foreign body and remove it through the natural passages. (This paper is not dealing with foreign bodies forced into the respiratory tract by

solution of continuity of the chest wall.) To do so one must first have a suitable bronchoscope and then be sufficiently familiar with its use to introduce it successfully. It can be done with local anæsthesia or under general anæsthesia or by the aid of a combination of both. Children in our experience require a general anæsthetic for the introduction of the tube through the larynx. A combination of general and local anæsthesia with preponderance of the latter may be used if the tube is to be introduced through a tracheotomy wound.

Adults submit to upper bronchoscopy under local anæsthesia with very little discomfort.

In immediate cases if the first or second trial prove unsuccessful, especially in fragmented objects of an organic nature, a tracheotomy should at once be done with the introduction of the bronchoscope, and, failing to find the object, a large tracheotomy tube should be inserted in the hope that coughing may bring out the offending material. This expedient in the case of J. P. might have given a favorable outcome as it did in the case of H. G.

J. P., an infant, was admitted to the surgical service of St. Luke's Hospital, April 18, 1913, with the history of having aspirated a glass bead from a necklace. Before admission two unsuccessful attempts had been made to enter the bronchoscope through the larynx by an outside physician. The cause of the failure was due to the relatively small size of the rima glottidis when compared to the size of the tube used.

When admitted the patient was suffering from pneumonia, and on account of her extreme condition no attempt was made again to pass a bronchoscope. A radiograph was taken, but before more could be done the patient died. No autopsy was allowed.

H. G., aged two and one-half years, was admitted to the surgical service at St. Luke's Hospital, November 14, 1914, with the history of having "swallowed" a fish bone. A radiograph was taken which gave the suspicion of a shadow in the upper part of the trachea. Œsophagoscopy and bronchoscopy failed to reveal a foreign body at this time. The patient was kept under observation for a few days and then, as he showed no further symptoms, was sent home. He was brought back December 3, 1914, suffering with slight dyspnœa, and an intubation was performed by the House Surgeon, Dr. Wells. After a short time another attempt at bronchoscopy was deemed advisable and, on account of the increasing dyspnœa, tracheotomy was prepared for. On attempting to pass the bronchoscope the child ceased breathing. With the assistance of Dr. Steele tracheotomy was rapidly done, and upon opening the trachea the

patient coughed out through the tube a slender piece of bone three-quarters of an inch long.

After that he made an uninterrupted recovery and was discharged on December 22, 1914, tracheotomy wound healed.

If the attempt to remove the foreign body has been successful in these fresh cases there need be but little fear of further complications, and the patient may be allowed to leave the hospital on the following day, if the peroral route alone has been used.

If the attempt has been unsuccessful and the object has not been coughed out after a tracheotomy, then the case passes on into the next class, that of deferred cases, unless the approach through a posterior bronchotomy be considered advisable and the patient's condition warrants it.

The development of symptoms in this transition stage is awaited with the gravest forebodings, for at this time begin the complications.

These may be pneumonia, gangrene, lung abscess and empyema, in the order named. Either one or all may result in fatality. Or there may be ulceration of the mucosa with perforation and a surrounding cellulitis or abscess formation and sepsis. Or there may be stricture of the bronchus and the development of a bronchiectasis.

In these conditions, should the patient survive the primary acute destruction of tissue, we have remaining a chronic condition with its connective tissue changes, in the centre of which still remains the foreign body.

Patients with these late complications then belong to the deferred class of cases and the foreign body present, which has acted as the exciting cause, still continues to act as an aggravation of the pathological condition until removal.

If the acute complications are survived the final condition of the untreated cases resolves itself into that of a chronic lung abscess containing the foreign body. These chronic lung abscesses resemble bronchiectases, they contain much pus beside the foreign body. Their walls may be irregular or smooth and they always are connected with the outside air by one, or even two, openings.

The patients as far as their symptoms go are suffering from bronchiectasis. They have a profuse intermittent purulent expectoration with greenish, foul-smelling pus. Their cough is worse on lying down. They suffer from afternoon temperature, have a hectic look, but rarely if ever does the sputum contain tubercle bacilli. They have clubbed fingers, especially if the duration of their illness has been over a year.

The treatment of these deferred cases consists of removing the

offending object, and of securing drainage of the purulent accumulation present. This will for a time improve the general condition, but the cavity caused by the foreign body will be very hard to heal. Many of these cases are opened from the outside and a bronchial fistula results. The purulent exudate is mostly discharged through the outside opening and, while doing so, the patient will remain improved. But when the outside opening is closed the patient again will return to nearly as bad a condition as before the removal of the foreign body.

One case of ours, F. B. (Fig. 5), illustrates this well.

Again there may be prompt healing of the outside wound with a great general improvement in the amount and character of the pus coughed up.

In general, the cavity formed by one of these foreign bodies must be treated along the lines of conservative surgery as applied to bronchiectasis.

In a very comprehensive paper by Dr. Willy Meyer on "Bronchiectasis," both the non-operative and operative treatment of this condition are fully discussed. And one cannot do better than to refer to it for a complete history of the current procedure in this class of cases.⁸

Suffice it to say, it requires all the ingenuity one may possess in order to effect an obliteration of one of these lung abscess cavities. In the attempt to treat this condition surgically it is well to proceed by stages, and it is wise not to be too radical with each step. It may even be advisable to allow the patient to enjoy a reasonable degree of comfort rather than subject him to a severe procedure which may jeopardize his life, in the hope of a complete cure.

It is to be noted that in these chronic lung abscesses of long standing the amount of pleuritic adhesions present may be surprisingly and embarrassingly small. One must look to find them far less dense and less extensive than in the recent cases of pleuritic inflammation.

Summing up, the following conclusions may be drawn:

1. All recently aspirated foreign bodies should first be sought by the Röntgen-ray and the bronchoscope, without delay, and removed if possible through the mouth.

2. Failing to remove them through the mouth a tracheotomy should be done and another attempt made by means of the bronchoscope.

3. Failing in this the tracheal wound should be held widely open by wires or a large tube in the hope that the foreign body may be coughed out.

4. If immediate removal by these methods fail, a period generally elapses in which the patient may undergo secondary changes in the lung.

such as pneumonia, gangrene, abscess and generally an overlying empyema.

5. If the patients recover from these acute infectious processes, they pass into the class of deferred cases with the foreign body still present as an aggravating factor in their chronic lesion.

6. Removal of the foreign body in these deferred cases does not always effect a cure.

7. The lung abscesses must be treated along surgical lines and even then we cannot always hope for a cure, but rather only an amelioration of their affliction.

REFERENCES

- ¹ Poulet, Alfred: A Treatise on Foreign Bodies in Surgical Practice. N. Y., W. Wood & Co., 1880.
- ² Brünings, W., and Howarth, W. G.: Direct Laryngoscopy, Bronchoscopy and Œsophagoscopy. N. Y., Wm. Wood & Co., 1912.
- ³ Ingalls, E. Fletcher, and Friedberg, Stanton A.: Jour. A. M. A., February 21, 1914, vol. lxii, No. 8, p. 610.
- ⁴ Hirsch, Isaac S.: The Diagnosis of Foreign Bodies in the Alimentary and Respiratory Tracts of Children. Am. Jour. of Surgery, January and February, 1913.
- ⁵ Jackson, Chevalier: Foreign Bodies in the Trachea, Bronchi and Œsophagus. Laryngoscope, April, 1905, p. 258.
- ⁶ Garré and Quincke: Surgery of the Lung. N. Y., Wm. Wood & Co., 1913, p. 224.
- ⁷ Von Eicken, Carl: In a System of Treatment. A. Latham and T. Crisp English, vol. iii, p. 803.
- ⁸ Meyer, Willy: On Bronchiectasis. ANN. OF SURGERY, July, 1914.

TUBERCULOSIS OF THE BREAST*

A REPORT OF 10 CASES

BY LUIGI DURANTE, M.D.

AND

WM. CARPENTER MACCARTY, M.D.

OF THE MATO CLINIC, ROCHESTER, MINNESOTA

IN a previous contribution to the knowledge of tuberculosis of the female breast, one of us (Durante¹) reviewed the bibliography of the subject to January, 1914, and discussed the anatomic forms, histogenesis, symptoms and therapy. This paper appeared contemporaneously with the excellent and extensive contribution upon the same subject by Deaver² and Herman.

Since January, 1914, four other papers by Leriche,³ Pirrung,⁴ Roffo⁵ and Miles⁶ have appeared and described two types of mammary tuberculosis, namely, the "sclerotic" and "inflammatory" types.

A review of the literature reveals the following important points:

1. The period of apparent greatest susceptibility to mammary tuberculosis is between the twentieth and fortieth years of life. The condition has been found only twice in the female breast before puberty and only ten times in the male breast. A total of 180 cases of all types in the male and female have been reported.

2. Many terms, such as "disseminating," "confluent," "miliary," "nodular," "abscess," "sclerotic" and "inflammatory," have been applied to the various aspects of the condition.

Retraction of the nipple has been reported and is, therefore, a sign which might readily be confused with a similar characteristic of mammary cancer.

3. Seventeen cases (Klose⁷) have been reported in association with neoplastic processes. Practically all observers attributed no relation between the two conditions.

4. The localization of the infection in the breast through an abrasion of the skin, although a possibility, has been considered a remote probability.

5. Practically every case presented itself as a secondary localization from a primary focus in some other portion of the body.

* Submitted for publication, February 21, 1916.

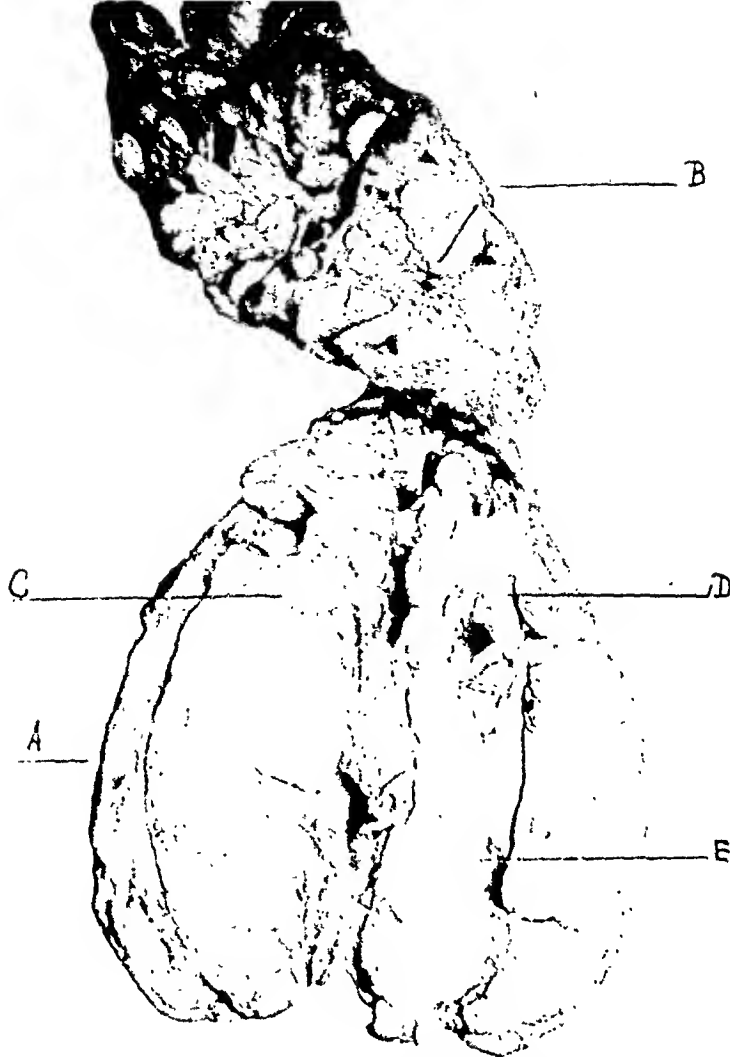


FIG. 1.—(52798) Tuberculosis of the axillary and pectoral lymphatic glands. *A*, breast; *B*, pectoral lymphatic; *C* and *D*, tuberculous glands in the breast.

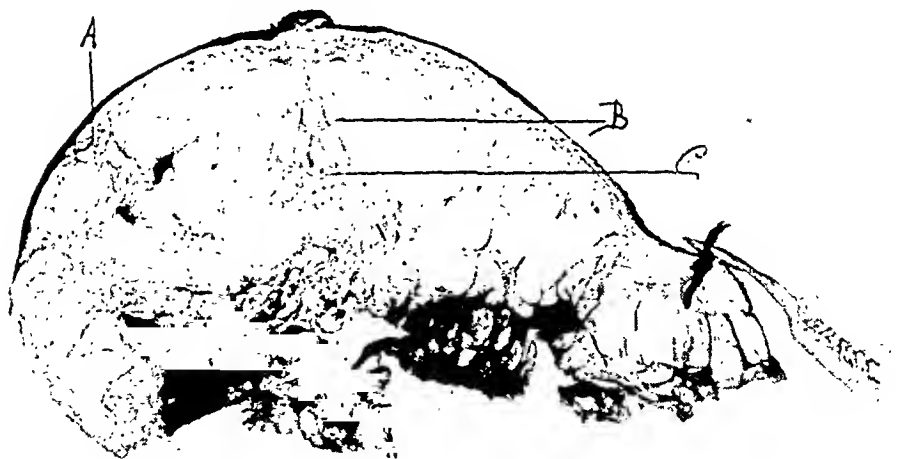


FIG. 2.—(63635) Tuberculosis of the breast, apparently produced by retrograde diffusion from tuberculous axillary adenitis. *A*, *B*, and *C*, tuberculous areas.



FIG. 3.—(52798) Photomicrograph ($\times 50$, Unna-Pappenheim stain). Zone of division, between tuberculous nodule, *A*, and parenchyma of the breast, formed by a barrier of dense connective tissue, *B*. The section was taken from point *D*, Fig. 1.

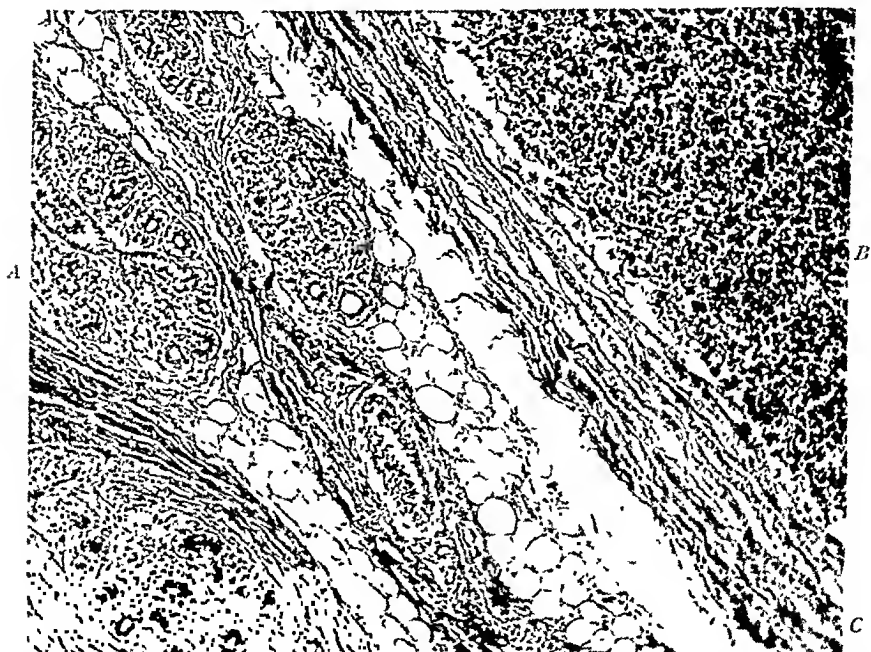


FIG. 4.—(52798) Photomicrograph ($\times 60$, Unna-Pappenheim stain) showing zone of division between tuberculous nodule, *B*, and the parenchyma of the breast, *A*. *A*, primary hyperplasia (MacCarty) of mammary acini, surrounded by connective tissue and a slight lymphocytic infiltration; *B*, margin of tuberculous nodule; *C*, barrier of connective tissue, dividing mammary parenchyma from tuberculous nodules. The section was taken from point *C*, Fig. 1.

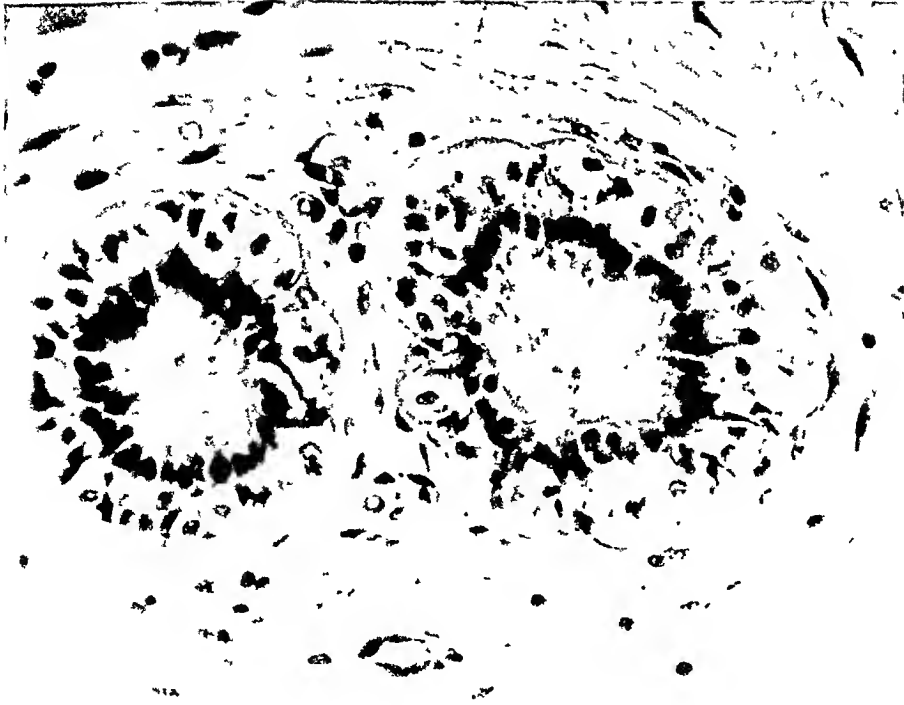


FIG. 5.—(52798) Photomicrograph III ($\times 120$, Weigert-Van Gieson stain) showing primary hyperplasia (MacCarthy) of mammary acini and connective tissue reaction at point *E*, Fig. 1.

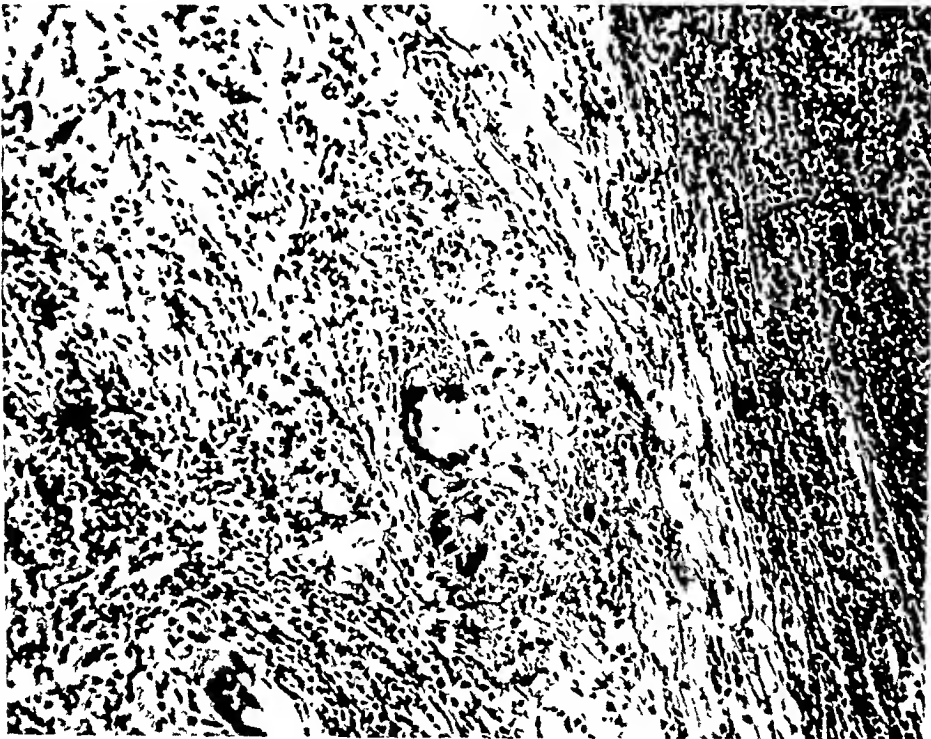


FIG. 6.—Photomicrograph ($\times 120$, Unna-Pappenheim stain) showing structures which may be either tuberculous giant-cells or atrophic nuclei.

6. In the cases which have been reported the most plausible mode of infection was by contiguity with pleural or costal tuberculosis or through blood or lymph streams.

7. All observers considered the blood stream to be the most common route of infection. In some cases, however, no tangible primary focus was discovered.

8. In certain cases the organism was, apparently, carried reversely from the cervical or axillary lymphatic glands which were demonstrably tuberculous. Some cases were attributed to an infection of the retro-sternal lymphatics which follow the collateral branches of the internal mammary artery. Mammary tuberculous infections which were secondary to axillary lymphatic involvement on the same side were described by Duret,⁸ Verneuil,⁹ Berchtold,¹⁰ Salomoni,¹¹ Caminiti,¹² Scott,¹³ Schmidt,¹⁴ Duvergey,¹⁵ Vignard,¹⁶ Pasquier,¹⁶ Putzu,¹⁷ Leriche,³ Roffo,⁵ and Durante.¹ Scott,¹³ Bahuand,¹⁸ Braendle,¹⁹ and Cignozzi²⁰ described the condition as secondary to cervical lymphatic involvement.

In the Mayo Clinic from 1904 to 1915 there have been 10 cases (0.51 per cent.) of mammary tuberculosis in a series of 1933 pathologic mammary conditions.

Deaver² found 0.83 per cent., Scott,¹³ 1.4 per cent., and Bloodgood,²¹ 0.6 per cent. of their mammary specimens tuberculous.

In the 10 cases observed by the writers there were three in which no primary focus was clinically demonstrable; there were three associated with tuberculosis of the lungs and three cases associated with no other clinical tuberculous lesion other than tuberculosis of the axillary lymphatic glands, and one which was associated with a pleurocostal lesion.

The gross pathologic picture is one of chronic mastitis characterized by a dirty discoloration of the normally pearly-white glandular tissue, bloody discoloration of fat, cysts, fibrosis, lymphocytic infiltration, localized areas of caseation and giant-cells.

A microscopic diagnosis is essential in practically all cases. This frequently must be aided by the demonstration of the bacillus tuberculosis in smears, cultures, tissues, or by injection into guinea-pigs. The histologic diagnosis is often difficult or impossible because disintegrating atrophic acini, when surrounded by necrosis and fibrosis, sometimes resemble giant-cells. Mistakes are, therefore, not infrequent.

A correct diagnosis from a histologic stand-point can be made only when typical tubercles with caseation, epithelioid cells and giant-cells with peripheral nuclei are present.

TUBERCULOSIS OF THE BREAST

| Off. No. | Sex | Age | Tuberculosis heredity | Tuberculous lesions in other organs | General health | Type of lesion | Number of lesions | Side involved | Quadrant of location | Nipple | Skin | Enlargement of axillary glands | Enlargement of cervical glands | Breast pain | Pathology | Koch's bacilli in the histologic sections |
|----------|-----|-----|-----------------------|--|----------------|-------------------|-------------------|---------------|-----------------------------|-----------|---------------------|--------------------------------|--------------------------------|-------------|---|---|
| 4522 | M | 52 | - | ++ lungs; left empyema | Poor | Abscess | Single | Lt. | Lower | - | Slight inflammation | Rt. - | Lt. - | - | Tuberculosis. | + |
| 7475 | F | 28 | - | Lungs | Poor | Nodular | Single | Lt. | Upper exterior | - | - | Rt. - | Lt. - | + | Tuberculosis. | + |
| 8102 | F | 23 | + | Lungs | Poor | Abscess | Single | Lt. | Lower exterior | - | Slight inflammation | Rt. - | Lt. - | Slight | Tuberculosis. | + |
| 2259 | F | 27 | + | Lungs | Poor | Nodular | Mult. | Lt. | Upper exterior | - | - | Rt. - | Lt. - | Slight | Tuberculosis of breast. | + |
| 6353 | F | 40 | - | - | Good | Nodular | Single | Rt. | Upper exterior | Retracted | - | Rt. - | Lt. - | Slight | Tuberculosis of breast. | + |
| 9700 | F | 26 | - | Lungs | Poor | Nodular | Mult. | Lt. | Upper exterior | - | - | Rt. - | Lt. - | Slight | Tuberculosis of breast and glands. | + |
| 9700 | F | 26 | - | Lungs | Poor | Nodular | Mult. | Rt. | Upper exterior and interior | - | - | Rt. - | Lt. - | Slight | Tuberculosis of breast. | + |
| 17117 | F | 22 | - | - | Good | Cyst | Single | Lt. | Nipple region | - | - | Rt. - | Lt. - | Slight | Tuberculous wall of cyst. | + |
| 21077 | F | 41 | - | - | Good | Fistula | Single | Lt. | Upper exterior | - | Ulcerated | Rt. - | Lt. - | Slight | Tuberculous mastitis. | + |
| 52798 | F | 28 | - | - | Fine | Diffuse sclerosis | Single | Rt. | Generalized | Retracted | - | Rt. - | Lt. - | Slight | Tuberculous mastitis; tuberculous glands. | + |
| 63625 | F | 42 | - | Right adnexa and appendix removed elsewhere 2 years before | Poor | Diffuse sclerosis | Single | Rt. | Generalized | - | - | Rt. - | Lt. - | Slight | Tuberculosis of breast and glands. | + |

TUBERCULOSIS OF THE BREAST

LITERATURE

- ¹ Durante, L.: Contributo clinico e anatomo-patologico allo studio della tubercolosi della mammella muliebre. *Policlin*, 1914, xxi, Sez chir., 319-335.
- ² Deaver, J. B.: Tuberculosis of the Breast. *Am. Jour. Med. Sc.*, 1914, cxlvii, 157-185.
- ³ Leriche: Tuberculose inflammatoire et maladie kystique du Sein. *Lyon méd.*, 1914, cxxii, 1076.
- ⁴ Pirrung, J. E.: Tubercle of the Mammary Gland Simulating Cancer. *Lancet-Clinic*, 1914, cxi, 563.
- ⁵ Roffo, A. H., and Landivar, A. F.: A propósito del origen linfático de la Tuberculosis mammaria. *Prensa méd. Argentina*, 1914, i, 33-37.
- ⁶ Miles, A.: Notes on a Series of Cases of Tuberculosis of the Mamma. *Edinb. M. J.*, 1915, xiv, 205-209.
- ⁷ Klose, H.: Tuberkulose und Neubildung. I. Tuberkulose mit Adenocarcinoma der Brustdrüse. *Beitr. z. klin. Chir.*, 1910, lxvi, 1-7.
- ⁸ Duret, H.: Tuberculose mammaire et adénite axillaire. *Progrès méd.*, 1882, x, 157.
- ⁹ Verneuil: Quoted by Deaver, *l. c.*
- ¹⁰ Berchtold, E.: Ueber Mammatuberkulose (Basel), *Uster*, 1890.
- ¹¹ Salomóni, A.: Tubercolosi e tumori condromatosi della Mammella. *Clin. chir.*, 1901, ix, 169-178; 251-257.
- ¹² Caminiti, R.: Sulla tubercolosi primitiva della Mammella. *Riforma med.*, 1903, xix, 869-905.
- ¹³ Scott, S. R.: Tuberculosis of the Female Breast. *St. Bartholomew's Hosp. Rep.*, 1904, Lond., 1905, xl, 97-123.
- ¹⁴ Schmidt: Lubeck, 1905 (Kiel), *Inaug. Dissert.*
- ¹⁵ Duvergey: Tuberculose mammaire par voie lymphatique rétrograde à la suite d'une plaie infectée de la main. *J. de méd. Bordeaux*, 1911, xli, 841.
- ¹⁶ Vignard and Pasquier: Tuberculose du sein par Infection ascendante? (Point de départ; tuberculose, osseuse du pouce). *Gaz. méd. de Nantes*, 1912, 2s., xxx, 493.
- ¹⁷ Putzu, F.: Contributo allo studio della tubercolosi della mammella. *Arch. internat. de chir.*, 1912-1913, vi, 222.
- ¹⁸ Bahuand: Tuberculose du sein. *Gaz. méd. de Nantes*, 1906, xxiv, 317-319.
- ¹⁹ Braendle, E.: Tuberkulose der Brustdrüse und die Dauerresultate ihrer operativen Behandlung. *Beitr. z. klin. Chir.*, 1906, l, 215-228.
- ²⁰ Cignozzi, O.: Amputazione della mammella col metodo Tansini per tubercolosi. *Policlin*, 1910, xvii, sez. prat., 811-813.
- ²¹ Bloodgood: In Kelly, H. A., and Noble, C. P.: *Gynæcology and Abdominal Surgery*, Phila., Saunders, 1907, ii.
- ²² MacCarty, W. C.: Histogenesis of Cancer of the Breast and Its Clinical Significance. *Surg., Gynæc. and Obst.*, 1912, xvii, 441-459.

A DENTAL PLATE IN THE ŒSOPHAGUS

BY GILBERT D. GREGOR, M.D.
OF WATERTOWN, N. Y.

ON November 27, 1915, Dr. S. C. Hollis, of Belleville, N. Y., referred Mr. L. P. to me, who gave the following history: Two days ago while eating his Thanksgiving dinner he experienced a sudden choking sensation and immediately missed a dental plate from his mouth. All efforts to rescue the plate were futile. On Saturday he consulted Dr. Hollis, who sent him to me. There was considerable pain in the throat and tenderness just above the suprasternal notch and inability to swallow anything except liquids in small amounts. As he was compelled to return to his home that night nothing was done until Monday, when he entered the Watertown City Hospital. Tuesday Dr. W. J. Kellow of the Hospital Staff made an X-ray picture, which showed the plate lodged at the second constriction of the œsophagus, the upper edge of the plate being just below the cricoid cartilage and the lower border carrying the teeth just above the suprasternal notch.

This plate had been worn a number of years and was made to carry the four upper incisor teeth. Its lateral border did not overlap the alveolar process on either side, but was made to fit around a few teeth left in the upper jaw, thus making its lateral border irregularly serrated. The subsequent breaking off of these teeth made the position of the plate in the mouth rather insecure and led to the unfortunate accident that spoiled his Thanksgiving dinner.

At this time the patient was in constant discomfort and was unable to swallow liquids of any kind. His voice had become husky and he was troubled with an annoying cough. He could only sleep in a semi-recumbent position and then by the aid of an opiate.

It seemed that it might be possible to remove the plate without a cutting operation, so I asked Dr. J. F. McCaw to examine the patient and the X-ray plates. On Wednesday, December 1, with the patient under full ether anæsthesia, Dr. McCaw made the attempt. The plate was easily exposed by means of the œsophagoscope, but all attempts to dislodge it, without the use of a dangerous degree of force, utterly failed, apparently on account of the serrated edges being buried in the mucous membrane. After over an hour's efforts this method was abandoned and the patient returned to his bed. On the next day he was again anæsthetized by Dr. McCreary and with the assistance of my associate, Dr.



FIG. 1.—Anteroposterior view, showing dental plate impacted in the œsophagus.

Gardner, I did the ordinary external oesophagostomy, going in on the left side, dividing, however, the anterior belly of the omohyoid muscle instead of simply retracting it. A few veins from the thyroid gland to the internal jugular and the inferior thyroid artery were the only vessels of importance encountered. These were all clamped before being cut, so it was practically a dry dissection.

As soon as the middle layer of the deep fascia was divided and the carotid vessels drawn outward and the thyroid gland and trachea drawn mesially, the oesophagus came into view and the plate was plainly felt through its walls. An incision through the postero-lateral wall of the oesophagus directly on to the plate exposed it and it was carefully removed.

Following the advice of writers on the subject a stomach tube was passed into the stomach through the oesophageal opening and the wound closed around it. A small bit of gauze was placed against the oesophagus below the tube and the balance of the wound closed in layers. The patient was fed through the tube for five days, when it was removed and he was allowed a semisolid diet, care being taken to make some compression over the wound during the act of deglutition. The packing was removed on the sixth day and the patient was discharged from the hospital on the twelfth, with the wound practically closed. From the kindness with which the wound healed, I am inclined to think the stomach tube was unnecessary, and in another similar case should close the oesophageal wound at once, simply draining the external part of the wound.

THE APERIOSTEAL STUMP AND ITS CARE*

BY HENRY H. M. LYLE, M.D.

OF NEW YORK

PROFESSOR OF CLINICAL SURGERY IN THE COLLEGE OF PHYSICIANS AND SURGEONS OF COLUMBIA UNIVERSITY
ATTENDING SURGEON, ST. LUKE'S HOSPITAL

AFTER the preservation of the life of the patient, the goal of all amputations is the production of a useful stump. To obtain this three cardinal points must be observed: (1) Correct treatment of the soft parts; (2) correct treatment of the bone; (3) prevention of stump atrophy.

Assuming that the treatment of the soft parts is well standardized, we will confine our remarks to the treatment of the bone and the prevention of stump atrophy.

Modern surgical technic now demands that all amputations of the lower extremity yield stumps capable of directly supporting the whole weight of the body.

In amputations there are four methods of treating the bone: the osteoplastic, tendinoplastic, periosteal and aperiosteal. The osteoplastic is the ideal method, but requires ideal conditions; the tendinoplastic is of limited usefulness; the periosteal, although employed by the majority of the surgeons in this country, is inferior to the other methods and should be abandoned; while the aperiosteal, in the advent of complications in healing, is the only method which is likely to furnish a useful end-bearing stump. It is the simplest, the most universally applicable and the most practicable (Figs. 1 and 2).

The possibility of obtaining an end-bearing stump in a periosteal amputation through the thigh is scouted by the artificial limb makers. The few end-bearing stumps they come in contact with are osteoplastic stumps, or amputations through the epiphysis.

If you examine the standard artificial limbs for thigh amputations you will see that the stump socket is designed to avoid direct pressure on the end of the stump, and to transfer as much weight as possible to the pelvic girdle. That is, in America, we are not living up to the standard set by Bier.

In a paper¹ read before the American Medical Association in 1914, we called attention to the notoriously bad results obtained in amputation

* Read before the New York Surgical Society, February 23, 1916.

¹ Lyle, H. H. M.: Jour. A. M. A., October 3, 1914, lxiii, pp. 1149-1152.

through the shaft of the femur, and strongly advocated the employment of the aperiosteal method where the osteoplastic could not be used.

During the past year it has been our good fortune to have the privilege of examining numerous amputation stumps both here and abroad. As a member of the Technical Committee for furnishing artificial limbs for France we have had the opportunity of examining a large number of amputation stumps from different parts of this country. These demonstrations have been furnished by makers applying for contracts. In forty-seven femur cases we have seen only two true end-bearing stumps. In the majority of these cases we feel that the fault did not lie with the technic of the operator, but with the method of the bone treatment and the after-care of the stump.

The aperiosteal method aims to produce a painless supporting stump capable of early functional use. The essential points of the technic consist in removing a small cuff of periosteum from the bone stump and spooning out the marrow cavity for a like distance, plus the after medicomechanical treatment of the stump.

Technic.—A small cuff of periosteum, 0.5 cm. in depth, is removed and the removal is carried out in such a manner that no shreds of periosteum remain. Such shreds retaining their primitive osteogenetic function are capable of producing painful bony spikes, which would interfere with the early functional use of the stump (contrast Figs. 1 and 2 with 3).

Fig. 4 shows the result of incorrect technic. In this case instead of sawing through the bone the operator raised a cuff of periosteum, sawed through the bone, and then cut away the periosteal cuff. In other words, there was an unnecessary stripping of the periosteum with the resultant formation of numerous osteophytes. In Fig. 1 the bone and periosteum were divided together and the periosteal cuff carefully removed from above downward, the marrow being scraped for a corresponding distance. More than 1 cm. should never be removed on account of the possibility of bone necrosis.

The After-care of the Stump.—The best formed stump if not quickly put to use as a real support may become atrophied and useless (Figs. 5 and 6). It is this special feature of the aperiosteal method that we wish to emphasize. The patient is put to bed with the leg elevated. As soon as the wound is healed begin Hirsch's medicomechanical treatment. Massage the stump twice daily, and after each treatment rub in a 2 per cent. solution of salicylic acid in olive oil. At night bathe in a warm sodium carbonate solution. Protect the stump with lamb's wool. Place a box at the foot of the bed and have the

HENRY H. M. LYLE

patient press the stump against it for from five to ten minutes three times a day; then four times; finally every hour. After each treatment energetically flex and extend the hip and knee. Now begin standing exercises. Rest the stump on a bran-bag or a cane-seated chair, at first placing the weight evenly on both legs; later place all the weight on the stump. At the end of two weeks the patient should be able to

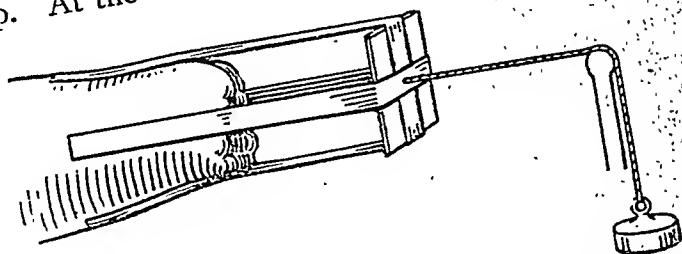


FIG. 7.—Extension applied to the soft parts to prevent retraction. Applicable in cases which have become infected or which have been treated by the open method.

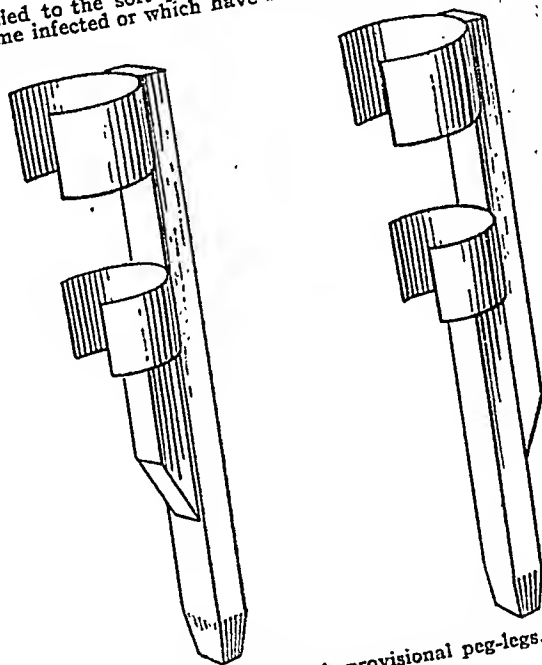


FIG. 16.—Hirsch's provisional peg-legs.

wear a peg leg, later a permanent prosthetic appliance which directly receives the weight through the end of the stump (Figs. 7-16).

If a surgeon decides to perform an aperiosteal or any other type of amputation he has no moral right to undertake it if he is not willing to carry out an after-treatment which aims to provide a painless end-bearing stump. To allow a maimed man to go through life with an



FIG. 1.—Result of an aperiosteal amputation of the thigh in a man sixty-four years old. Note smooth stump end and absence of bone atrophy. Patient was able to bear his whole weight on the end of the stump within fourteen days and walked on a provisional peg-leg within eighteen days.



FIG. 2.—Result of aperiosteal amputation. Note the smooth stump and the absence of bone atrophy.

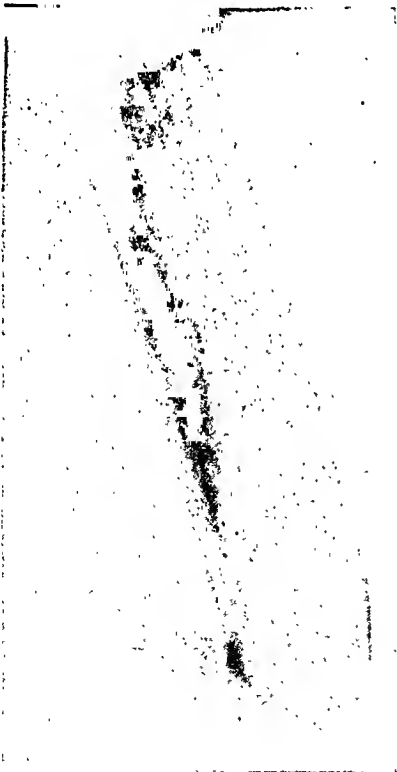


FIG. 3.—Painful stump, due to bony spicules resulting from periosteal amputation of the thigh.

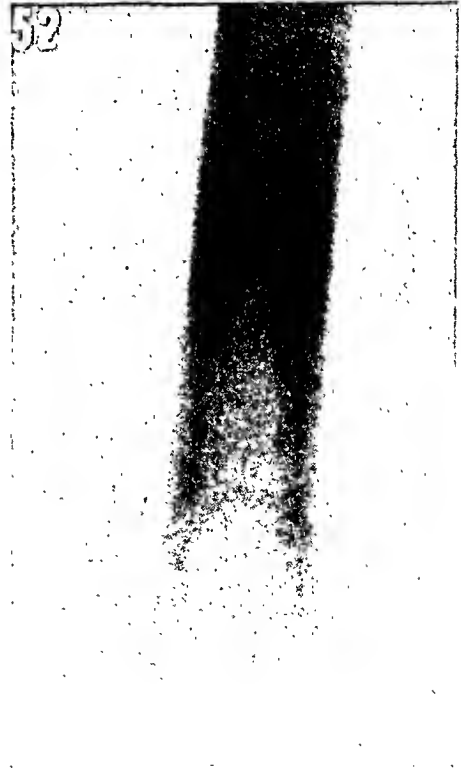


FIG. 4.—Result of aperiosteal amputation incorrectly performed. Note spicules of bone. These were smoothed off by early functional use.



FIG. 5.—A painful conical stump, the result of periosteal amputation of the thigh. The patient was unable to bear any weight on the stump.

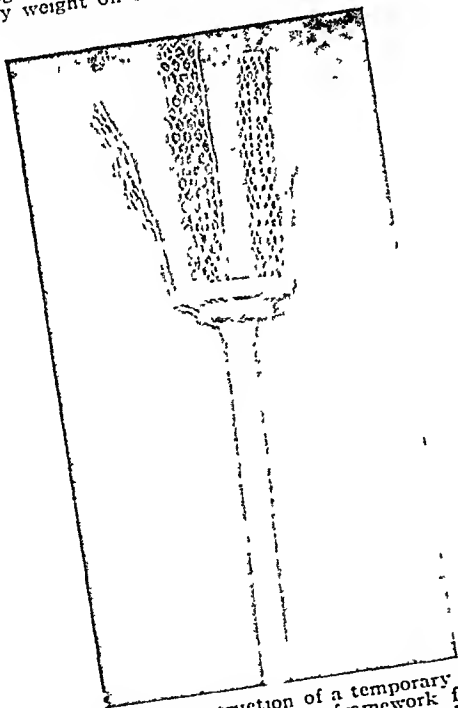


FIG. 8.—Construction of a temporary end-bearing peg-leg: Skeleton framework. The plaster temporary end-bearing peg-leg. The plaster framework for the stump is constructed around a bucket for the stump. This framework consists of a circular disc of wood the size of the stump (the common fault is to make this too wide). The central peg is formed from a rake handle. Strips of wire mesh are secured to the wooden disc and peg by staples. The longer strips are placed externally.

FIG. 6.—Painful atrophic stump one year after periosteal amputation of the thigh. Shows baneful results of disuse, stump shrinkers, etc.



FIG. 9.—Construction of a temporary end-bearing peg-leg: A seamless sock is drawn over the stump and a few turns of plaster applied in such a manner that the stump end is left open.



FIG. 10.—Construction of a temporary end-bearing peg-leg: The framework of the peg-leg has been applied over the plaster and fixed in place by interweaving the turns of the bandage between the strips of wire netting. This insures a firm union of the plaster and netting, reduces weight and strengthens the plaster bucket. Note that the plaster extends from the bucket over the disc to the peg; this braces the union between the disc and the peg. The weight of the stump rests against a felt pad and a layer of lamb's wool. The lamb's wool to be renewed when necessary. The walking end of the peg is furnished with a rubber tip.

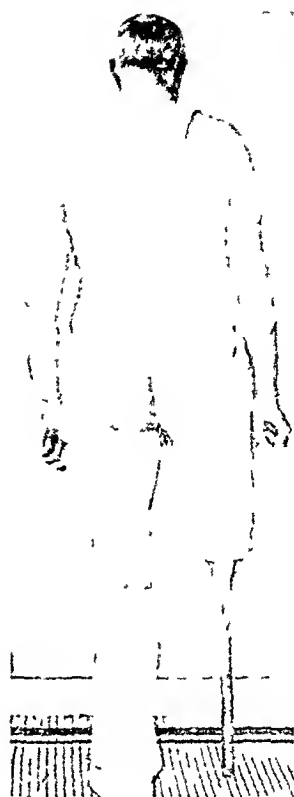


FIG. 11.—Construction of a temporary end-bearing peg-leg: Posterior view, showing the arrangement of the supporting straps. These straps are incorporated into the plaster on the interweaving principle.



FIG 12 —Aperiosteal amputation bearing his weight on the stump, days after the healing of the wound (Amputation performed by F. Mathews.)

Patient fourteen



FIG 13.—Aperiosteal amputation. Patient exercising with peg-leg



FIG 14 —Aperiosteal amputation Patient exercising with peg-leg



FIG 15 —Aperiosteal amputation Patient wearing a home-made peg-leg Patient was able to walk on this leg fourteen days after the healing of the wound.

THE APERIOSTEAL STUMP AND ITS CARE

ever-present painful stump is a heavy responsibility. Except you have come in contact with a large number of these sufferers you can scarcely realize what the problem means. One thing I am sure of ; they have a very poor opinion of surgeons and surgery. We must ask ourselves if this estimate is just. Considered in the light of past standards it is not ; considered in the light of the higher standard set by Bier it is.

An early functional use of the stump is the best method of preventing atrophy. This is in direct opposition to the accepted teachings of this country. The majority of patients are turned over to the artificial limb maker, who institutes a course of stump shrinking, which lasts from three to six months until a permanent atrophy of the stump is obtained. The atrophied stump is then considered ready for a permanent prosthetic appliance. Unfortunately, these appliances are designed to aid and abet the vicious atrophy-producing theory. The whole treatment is an attempt to make a part strong by using every known physiological and mechanical means to make it weaker.

CONCLUSIONS

1. No stump should be considered good unless it is capable of supporting the whole weight of the body.

2. Judged by this standard the average American stump is a failure.

3. The number of poor results obtained by competent operators shows that the periosteal method rather than the operator is at fault. •

4. As soon as the wound is healed, institute the physiological treatment of the stump with the object of developing its weight-bearing powers. Avoid all procedures which cause atrophy.

5. The best formed stump if not quickly put to use as a real support may become atrophied and useless. Within two or three weeks of the healing of the wound begin walking on a provisional peg-leg. Such peg-leg to be applied so that the stump takes all the weight on the end.

6. Insist that the permanent artificial leg be built on the end-bearing principle.

A METHOD OF FACILITATING INFILTRATION ANÆSTHESIA

BY WILLARD BARTLETT, M.D.

OF ST. LOUIS

BRAUN issues the dictum that an all metal hand-syringe is the proper instrument for administering local infiltration anæsthesia, but there is a loss of the operator's time and energy in the effort of refilling, if one syringe is used, and the same prodigality in changing and reintroducing, if more than one is employed.

The patient is conscious of a prolonged ordeal because of the ordinary refilling and changing of syringes, and there is unavoidable knowledge and strain incident to the many needle reintroductions, due to refilling through one needle.

The simple apparatus required, as seen in the cut, can readily be assembled in any hospital on short notice. It consists of a supply tank holding about 500-1000 c.c., with gravity flow, a rubber hose about one metre long, and an ordinary two-way cock which can be obtained with metal syringes of convenient sizes—my own preference is for one of 10 c.c. capacity. A one-half per cent. solution of novocaine, with 1 c.c. of adrenalin 1-1000 added for every 200 c.c. of novocaine, is used in almost any quantity desired without fear of toxic symptoms, after the well-known technic of Braun.¹

A field of about 18 cm. in diameter, large enough for most purposes, can be infiltrated through a single puncture using about a 9 cm. needle.

Make the ordinary intradermal bleb with a tiny hypodermic needle, then introduce the large needle painlessly through it, continuing, with the needle in place, to empty and fill the syringe as rapidly as the piston can be forced in and out while an assistant shifts the stop-cock in the direction indicated. The apparatus carries out the simple mechanical principle underlying the single-acting force pump.

Air should be carefully expelled as usual, before the first introduction of the needle. There is no possibility of its subsequent introduction, provided the stop-cock be switched to intake just before each piston down-stroke is completed.

The above obtains, of course, only for syringes with needles firmly attached. Those with slip joints are not suitable, to the writer's mind, on account of the frequency with which they "blow off."

Braun² used an apparatus like this one for injecting larger amounts

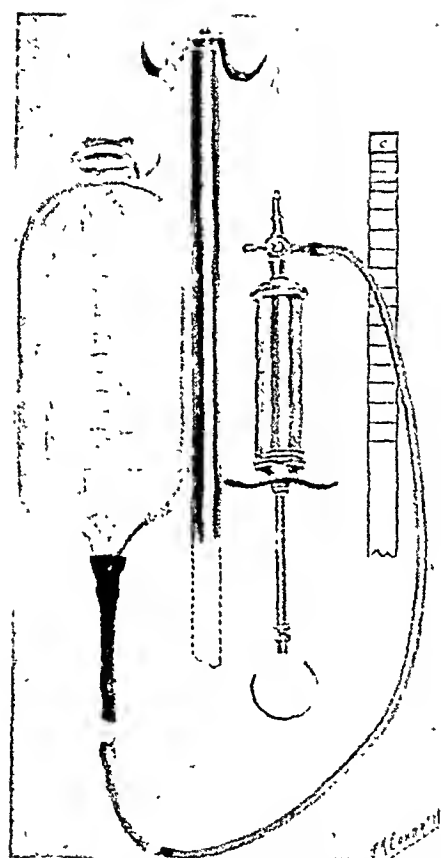


FIG. 1.—Showing container, syringe with two-way cock and infiltrating needle; also centimetre measure.

of fluid, but he makes no mention of it in his last (third) edition. This article is written in the hope that a valuable method will not disappear because the chief exponent of local anæsthesia has ceased to favor and advise its use.

The plan was original as far as the writer is concerned and had been used by him with the greatest satisfaction long before he discovered that it had been employed and discarded by Braun. Naturally, Braun gets any credit for priority and it is to be hoped that he will replace it in a future edition of his valuable work.

Zawodski and Strauss² used an apparatus similar to the one pictured, but having an automatic valve which is stated by Braun to have proven unreliable and troublesome.

Matas³ improvised an injecting outfit by utilizing a Potain aspirator with the valves reversed. An ordinary bottle is used to hold the anæsthetic solution and the stopper with stop-cock connections is held in position by a clamp provided with thumb screws to prevent the pressure forcing out the stopper. He also advises against slip-fitting connections. The pumping apparatus forces air into the bottle instead of creating a vacuum; this is then detached and the outlet tube with the needle is attached. The bottle is inverted and held in position by an assistant.

Allen,⁴ in his book on "Local and Regional Anæsthesia," illustrated a Matas apparatus which employs the above principle in a perfected and simpler form.

Stille and Moskovicz² devised machines which worked on the principle of that used by Matas.

Hammer⁵ made an all-metal syringe into which the solution is poured from an opening in the side in front of the extended piston. The objection made to it is that the needle is fixed to the syringe and must be withdrawn to fill.

The Shield⁶ syringe is a modified Hammer, which has a slip-joint needle attachment, and a collar about the side opening to facilitate filling.

Spiegel² employed a syringe which filled automatically by means of a coiled spring in front of the piston.

Kuhn⁶ uses what resembles a tire pump to produce air pressure 2-4 times that of the atmosphere, within a 200-300 gm. flask, containing novocaine and adrenalin and in this way produces a constant stream through the needle, the same being interrupted at will by a sort of trigger arrangement.

The consensus of surgical opinion is in favor of introducing fluid

by direct finger pressure on a piston, that giving the best possible control; since a syringe is to be used, one inclines naturally toward a "filling" method which insures the maximum of satisfaction for both patient and surgeon.

REFERENCES

- ¹ Braun: Lokal-anæsthesie. Dritte Auflage, Leipzig, 1913.
- ² Braun: Lokal-anæsthesie. Zweite Auflage, Leipzig, 1907.
- ³ Matas: Local and Regional Anæsthesia. Phil. Medical Journal, November 3, 1900, vi, 820.
- ⁴ Allen: Local and Regional Anæsthesia. W. B. Saunders, Phila., 1915.
- ⁵ Braun: Local Anæsthesia. Third edition, translated by Shield, Lea & Febiger Co., Phila., 1914.
- ⁶ Kuhn: Pneumatische-Anæsthesie. Münchener med. Wchschr., November, 1914, lxi, 2222.

CALCAREOUS DEGENERATION OF THE PROSTATE GLAND *

REPORT OF A CASE

By G. SHEARMAN PETERKIN, M.D.

OF SEATTLE, WASHINGTON

PATIENT S429; male, aged fifty-nine. In August, 1900, fell on saddle horn; urethral hemorrhage; no retention, not even difficulty in urination. In January, 1901, five months later, confined to bed with bladder trouble. At this time claimed abscess broke, as there was a copious discharge of thin pus from meatus, after which symptoms of cystitis were relieved, but recovery not complete. Prostatic distress and cystitis continued, but not severe enough to incapacitate. The following two years at intervals injected into bladder with a small piston syringe various medicaments, also catheterized self, using no sterilization for hand or catheter; lubricant, vaseline or saliva. During this period had no surgical treatment or other instrumentation.

In 1910 second accident; fell from bicycle and injured perineum. Suffered constant severe pain for four days; pain relieved by discharge of pus from meatus. On subsidence of acute symptoms, pain, tenesmus, etc., received prostatic massage and continued same for three months. During the following three years, 1910 to 1913, frequency of urination continued and semi-incontinency existed, to extent that patient passed unconsciously at intervals a small amount of purulent and fetid urine both day and night. Bladder capacity two or three ounces, judging from the amount of urine voided.

In 1913, first noticed a hardness and a constant enlargement in the prostatic area. Treatment received, general hydrotherapy and prostatic massage, without relief, but rather with an increase of symptoms. In 1914, lady osteopath massaged prostate for what she called "hard tumor."

Up to the time of consultation, continued to have prostatic distress and frequency of urination, with passage of very fetid and purulent urine, accompanied by considerable bleeding. No history of retention of urine.

Patient first seen October 11, 1915.

Subjective Symptoms.—Frequency of urination, every one or two hours during the day, less often at night. Burning pain during whole act, tenesmus at end of act; constant dull aching pain in perineum and in bladder above symphysis; occasionally in back.

* Read before the Swedish Hospital Clinical Society of Seattle, December 7, 1915.

Each act of urination was accompanied by considerable amount of bright blood, bleeding more pronounced at end of act. General appearance, anæmic, pasty and debilitated. Loss of weight, fifteen pounds. Appetite poor, bowels very constipated.

Clinical History.—Heart, irregular and weak, no pathologic condition present. Pulse, 64; temperature, 97. Radial and temporal arteries sclerotic. Catheterization of bladder, one-half ounce residual urine; considerable resistance to catheter as though stone present. Palpation per rectum gave tactile impression of a mass so round in outline, so smooth in contour as to give one an instant mental picture of a medium-sized Japanese orange, but an orange that was ossified, judging from its uniform stony hardness. Prostate not tender on pressure. Capacity of bladder, four ounces.

Cystoscopy.—Showed a subacute general cystitis, bladder wall trabecular, bladder filled with purulent urine, and trabecular cavities with inspissated pus; so extensive and tenacious was the pus that the cystoscopic medium could not be rendered clear enough for a thorough examination. When sufficient irrigating force and distention was employed to free mucopus from bladder wall and trabecular cavities, marked bleeding occurred. Ureters not catheterized; cause, cloudy character of medium and inability to move the cystoscope within range of either ureter due to contracted and inelastic prostatic urethra. Upon withdrawing cystoscope, prostatic urethra showed phosphatic mass, covered with mucus, and outline indistinguishable due to bleeding.

Laboratory Findings.—Complement fixation test for syphilis and gonorrhœa negative.

Urine turbid, the odor extremely offensive—not decomposed, but fecal; reaction acid; specific gravity, 1.025; albumin; no sugar; traces of indican; much pus; many red blood-cells; no casts. Microorganisms: Many bacilli, cocci, and numerous spirochætæ. These latter organisms, judging from the odor, belonged to the species of spirochætæ named by Noguchi "*Treponema microdentium*." Blood count, red, 4,300,000; white, 11,000. Blood-pressure, diastolic, 100; systolic, 150.

October 12, X-ray of bladder distended with boracic acid gave radiographic picture as shown in Fig. 1. October 14, bladder filled with normal salt solution gave radiographic picture as shown in Fig. 2; filled with air, Fig. 3; filled with silver iodide, Fig. 4.

Examination of these plates permits drawing the following conclusions:

1. That the X-ray is an essential as a means of obtaining direct and corroborative evidence of pathologic conditions of the bladder.



FIG. 1.—Radiograph showing concretions in bladder.

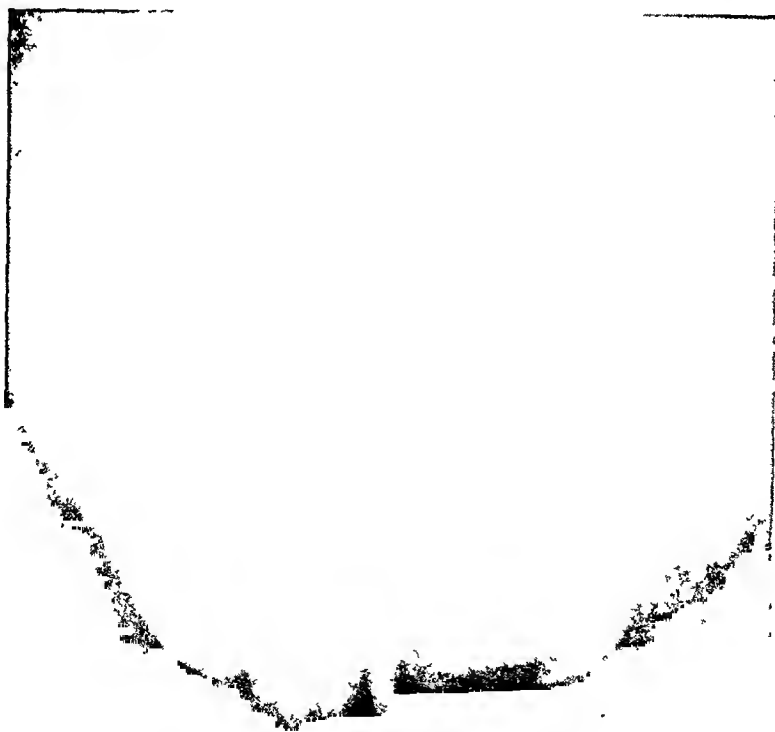
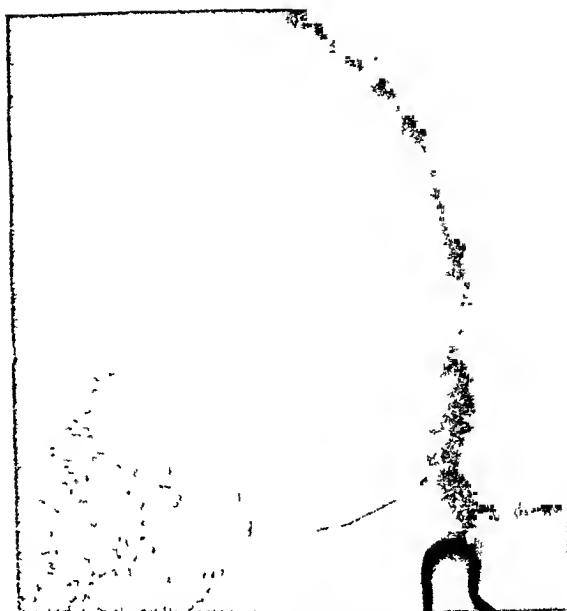


FIG. 2 —Radiograph of bladder filled with normal salt solution.



3—Radiograph of bladder filled with air



FIG. 4.—Radiograph of bladder filled with silver iodide solution



FIG. 6.—Prostatic stone.

In this case, the X-ray gives direct evidence, the cystoscope negative evidence.

2. Fig. 1 emphasizes an old adage: Thorough cleansing of the bowels obviates mistakes. The bowels not cleansed, present shadows as here shown.

3. Figs. 2, 3 and 4 illustrate the relative value of urine or aseptic fluids, air or oxygen, silver iodide or other solutions of like nature, as mediums for X-ray work. Comparing the shadows of the bladder in Fig. 2, filled with normal salt solution, and Fig. 3, filled with air, illustrates that air and oxygen as a medium will show concretions of low specific gravity, which may not be seen when the medium employed is urine or antiseptic solution.

4. Fig. 4 shows that silver iodide should be employed to outline the bladder; air and oxygen to ascertain the presence of foreign bodies. This plate, an exceptional and rather unique radiograph, shows distinctly the outline of an enlarged prostate and a tra-

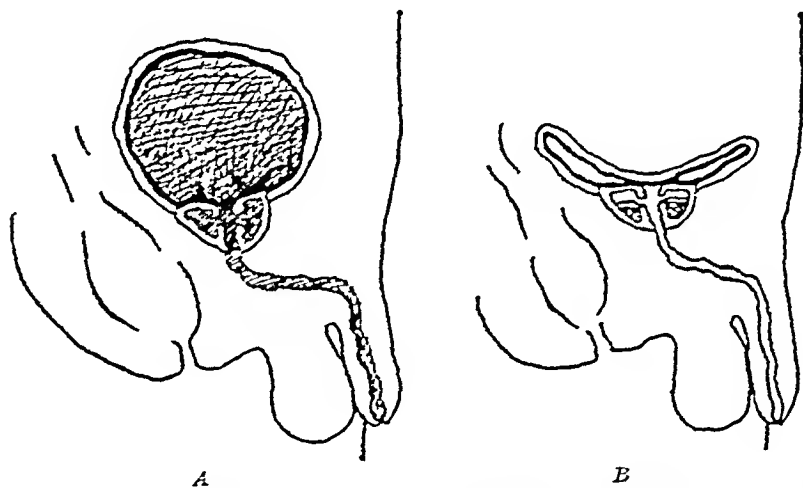


FIG. 5.—Drawing showing formation of prostatic stone. A, bladder filled; B, bladder empty; residue in prostate.

becular bladder above it. It contains also a diagnostic point of infinite value. This is the white shadow extending between lines *b* and *c*. This line is the compressor urethræ, and the fact that no shadow is cast shows that this muscle is functioning normally and that it has squeezed the silver iodide from between its anterior and posterior margins; whereas the line *a* shows that the mouth of the bladder is destroyed, which demonstrates in this peculiar case the necessity of operating suprapubically and not perineally, for a perineal incision would undoubtedly cause incontinency, even if incision did not involve the triangular ligament.

The diagrammatic drawing (Fig. 5) illustrates the mechanism whereby infection, combined with urinary deposits, gradually and

completely replaced a normal prostate and substituted one of stony formation.

October 22: Under spinal anaesthesia, cystotomy was performed and this semistony mass (Fig. 6), which completely filled the whole prostatic capsule, was removed piecemeal, virtually without bleeding. So completely did this mass fill the prostatic capsule that passing through its centre was a distinct canal through which the urine escaped. This calcareous prostate weighed 31 grammes and was composed almost entirely of calcium carbonate, with a small amount of magnesium and calcium phosphate. A large Freyer's suprapubic drainage tube; diameter $\frac{3}{4}$ inch, was inserted.

Difficulties encountered:

(1) The employment of sufficient force to break up the adamantine prostate, yet not cause the resulting jagged edges to pierce the thin prostatic capsule and produce a recto-prostatic fistula.

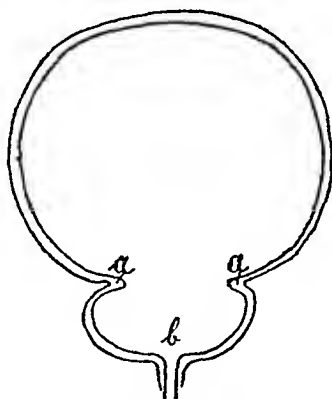


FIG. 7.—Bladder and prostatic cavity after operation.

(2) As soon as any portion of the stony mass was grasped by the forceps, it would partially crumble, and even though the greatest care was exercised, some particles and granules of this tenacious stony material, which had a pronounced sickening fecal odor, were distributed over the wound and held tenaciously to the prevesical fat, fascia, etc. Attempts to remove all such particles and thus prevent infection from same were made with gauze and small forceps.

At the end of the operation, a large uncollapsed (Fig. 7, *b*) prostatic cavity, with a circumference of a medium-sized Japanese orange, existed, and in place of the vesical sphincter there was an indurated ridge (Fig. 7, *a*) about one inch in diameter, that connected the prostatic and bladder cavities.

The following day patient's temperature rose to 99.4° , pulse 80. On October 24, temperature reached 100° – 101° , and from then

on varied from 100° to 101° , with a pulse from 80 to 96, until November 1, during which time the patient's condition was not of the best.

Due to the unremovable particles of the infecting granules left at the time of the operation, a very pronounced sloughing of the wounded area occurred and all of the stitches in the wound had to be removed. Patient complained of more or less constant pain in upper abdomen, over transverse colon, and general fatigue; also of inability to sleep, even if free from pain. Leucocyte count on October 27, 15,000; polynuclear, 87 per cent.; small leucocytes, 8 per cent.; enlarged leucocytes 2 per cent. Catheter inserted on October 25 in urethra to drain bladder; removed on October 27.

After-treatment consisted of irrigating the suprapubic wound, also bladder through this wound, and the urethra. Boracic acid and, later, 1:6000 permanganate solutions were employed, every four hours at a temperature of 110° F. in percolator.

At no period after operation could patient take nourishment in any quantity; nausea and pronounced constipation, with gastric and intestinal flatulence present, did not respond to varied forms of treatment. General appearance that of low grade of infection with dissolution.

On October 31, pulse was 100, temperature 99.4° . On November 1, ten days after operation, at twelve o'clock, without warning, a pronounced secondary hemorrhage occurred, which necessitated taking the patient to the operating room and packing prostatic cavity with gauze. Patient died November 2, from general debility and anæmia. Autopsy refused.

A case carefully studied often enables one to formulate a definite opinion as to the method of action in a similar case, yet in my mind one question of after-treatment remains unanswered.

This is the advisability of irrigation—was it or was it not a causative factor in the secondary hemorrhage? Here (Fig. 7) there are two cavities, the bladder and the prostatic cavity. The walls of the latter, though infiltrated, were thin and uncollapsible, and still clinging to it tenaciously were many small particles of this infectious crustation. The opening between this prostatic cavity and the bladder was patent. This prostatic cavity open, as it was, formed a dumping ground for infection and urinary deposits which would ultimately result, were it not cleansed, in the same pathologic condition as previously existed. On this theory, an attempt was made to keep it clean by irrigation, as stated. Was this method of procedure advisable? The question still remains unanswered.

THE TECHNIC OF SUPRAPUBIC CYSTOSTOMY IN BADLY INFECTED CASES

BY HADLEY WILLIAMS, F.R.C.S. (ENG.)
OF LONDON, CANADA

THE following procedure has been adopted during the last twelve months for suprapubic cystostomy, where a delay of a few days or a week is permissible, and in those cases where the bladder is badly infected, in order to aid by every possible means the recovery of a patient who is often old and decrepit with arteriosclerosis, thickened bladder and perhaps grave renal insufficiency.

Every surgeon knows how readily a normal bladder will unite when infection is absent or at a minimum, and the wall, itself, has been treated in a gentle and clean-cut manner. Until recently, the operation was performed at one sitting, whether for the removal of a foreign body or enucleation of the prostate; but this has been largely given up for the so-called "two-stage" operation, with much better results. This procedure goes a step farther in the class of case just mentioned, in order to insure the patient against the risk of septic infiltration of the paravesical connective tissue with its often serious consequences.

Cystotomy was first introduced by Franco in 1556, but only exceptionally performed in the earlier days on account of the great danger of infection, not only to the bladder, ureter and kidney, but also to the tissues of the abdominal wall and the fatty connective tissue in the space of Retzius. The mortality rate, in fact, was very high.

Aseptic treatment of wounds has worked marvels here as in all other fields, but has not wiped out the dangers of this operation. M. Guyon had a patient die with purulent infiltration of the subperitoneal connective tissue, and Jacobson lost a case with cellulitis on the fourth day. Cadge (in Treves's *Operative Surgery*) gives the rate of mortality in patients over fifty, after a suprapubic cystotomy for stone, as 27 per cent. The actual causes are not discussed. At any rate, all surgeons meet with sloughy conditions of the wound, induration, purulent infiltration and dangerous absorption in these cases and, aside from continual irrigation of the bladder and the use of the siphon, many have advised varied technic to remedy the trouble.

These patients are nearly all old with some sclerosed condition of the arteries, a liability to thrombosis, pneumonia and the like and with renal insufficiency, dependent more or less on the length and character

TECHNIC OF SUPRAPUBIC CYSTOSTOMY

of the obstruction. For instance, Poucet and Delorine think that by "suturing the edges of the bladder to the skin, infiltration of the tissues with infected urine is most effectually prevented." Kocher says, "It is better to insert a large tube for drainage down to the bottom of the bladder and pack external wound all around with antiseptic gauze, or stitch a tube into the bladder in a water-tight manner and siphon off the contents." Jacobson suggests "suturing the cut edges of the bladder and fascia and deeper edges of the wound to save the patient the great risks of extravasation."

It must be confessed that all these methods are incomplete, as, since the bladder is opened immediately, the infiltration of septic urine will be sure to occur to some extent around the sutured edges and the tube, no matter how thoroughly the technic has been carried out, to say nothing of the difficulty in bringing the skin edges and the bladder together, in very stout patients, and the injury from tension and suturing to its wall.

Freyer says in discussing prostatectomy, "The tube is left *in situ* for four days or more, for by this time plastic lymph will have been thrown out around the tube, thus shutting off the paravesical space from contact with the urine and avoiding cellulitis."

Note here that nothing is done to avoid this condition prior to the removal of the tube. It also seems that the less the bruising and the cleaner the cut into the tissues involved in cystostomy (other things being equal) the more rapid will be the resulting recovery and with less danger of septic absorption and the train of symptoms that follow. The danger of infection, indeed, would not be lessened by attempting to close off the urine by these methods, by burrowing into the paravesical spaces, but would be increased by tending to prevent sufficient exit if infection did take place; so that packing with gauze not only around the tube, above the region of the attachment of the peritoneum, and forward in the space of Retzius is much more scientific and effectual for the end in view. Indeed, when the tube is left in the bladder, most surgeons take the precaution to leave a strip of gauze for postpubic drainage in all their cases, which at least has the merit of attempted drainage away from the depth of the wound to the surface. At any rate, the thrombosed character of some of these wounds, and sloughing of the tissues with added danger to the patient already in a condition unable often to resist the least infection, to say nothing of the bed of the prostate when this is removed, necessitates some method whereby the wound can be sealed off before the escape of the infected urine. The method discussed here is applicable to the evacuation of pus from all cavities where delay is

possible and is in harmony with nature's own method in this direction.

Formerly surgeons went boldly down to the bladder and opened the cavity immediately. If tearing and bruising occurred, septic infiltration of the tissues sometimes occurred with unfortunate results.

The procedure adopted, then, to seal the wound is here briefly outlined and is quite simple.

A general anæsthetic with its evident dangers in this class of case is quite unnecessary. Some form of cocaine is used. The vertical incision is adopted rather than a transverse, so as to keep the superficial and deep parts of the wound parallel and present a solid wall on either side when completed, rather than an elongated skin wound stretching at right angles. The muscles are separated in the usual manner and the fatty tissues, with often large veins, carefully incised but not torn or roughly handled, since hemorrhage often occurs and may be difficult to control. M. Guyon met with severe hemorrhage in his second case.

Treves lays great stress on this point when he says that, "Prevesical fat should never be torn through; all such rough manipulations open the way for urinary infiltration."

In order to insure safety of the peritoneum, a catheter with an ordinary bulb is previously passed through the urethra and the bladder cautiously, and with extreme care, gently inflated. A warm boric solution is sometimes used instead of inflation and by some is considered safer. This brings the bladder wall into view and pushes the peritoneum out of danger. The fat is carefully reflected sideways and upward and the muscle fibres of the viscus are now easily recognized.

Gussenbauer, Sonnenburg and Kramer mention cases in which the peritoneum was adherent to the pubis. If this condition be found, it matters little, since it can be dissected away, displaced upward and, if necessary, sutured. The five or six days that elapse before the bladder is to be opened ensure the safety of the abdominal cavity. The bladder is now cleaned to the required diameter, according to the object to be removed. If for simple drainage, the space may be small. A guy suture of thread or silk is placed through the muscular coat on either side, fairly close to the median line, and left *in situ*, the ends being brought up through the wound for future use. A strip of sterile gauze about 3 cm. wide is packed into the depth of the wound and into the postpubic space and on either side, gradually and completely filling the cavity and forming a space perhaps 3 cm. or more in diameter. No sutures are inserted. An ordinary dressing is placed over the wound. The operation only takes a few minutes without the least shock or inconvenience to the patient.

At the end of the fourth day at the earliest, but one week usually, the second stage is undertaken. The packing is carefully removed and the wound found to be completely sealed in all directions. The bladder wall is easily recognized and the guy sutures point out the line of incision which, under a few drops of cocaine, is made in a vertical direction to the required length. Great care is taken not to clamp or bruise the bladder wall in any way. The finger is carefully inserted, a tube, if used, placed in position, the decomposing urine immediately pouring through the opening, but the granulations which have sealed the wound prevent any contamination of the paravesical cellular tissue. During the after-treatment the skin remains normal in color without the least sign of induration. There is no pain around the edges of the opening and the general appearance of the wound all that can be desired. In fact, other conditions being equal, a rapid normal healing takes place, with delayed union and primary fistula brought to a minimum. The comfort of these patients is in marked contrast to the discomfort experienced after the immediate cystostomy previously performed, which often left a dusky infiltration of the skin, sloughing tissues, and all the dangers of thrombosis and sepsis with continual care and attention of the nurse and with pain and misery to the patient. For suprapubic prostatectomy, in the worse forms of infected bladder, the "three-stage" operation is now always performed. For vesical calculus this method is ideal. Since there is practically no infection and no shock except that incident to opening the bladder itself, all cases of stone are now treated in this manner with the exception of those patients whose urine is in the best possible condition, and then immediate suture is adopted.

SHIRRING THE ROUND LIGAMENTS*

A NEW METHOD OF SHORTENING THE LIGAMENTS FOR RETRODISPLACEMENTS OF THE UTERUS

BY JOHN WESLEY LONG, M.D.

OF GREENSBORO, N. C.

OPERATIONS upon the round ligaments for the purpose of overcoming backward displacements of the fundus have developed much ingenuity and a great variety of methods. A multitude of men have contributed to this phase of pelvic surgery. The bare mention of a method, whether new or old, rarely fails to evoke an interminable discussion.

To this arraignment I plead guilty to the extent of having invented one operation for shortening the round ligaments some nine years ago and now come forward with a second.

Before the North Carolina Medical Society in 1907,¹ I read a paper with the title, "Preperitoneal Shortening of the Round Ligaments." The occasion and paper were rendered memorable by a rather spirited but good-natured discussion of the subject by that master of gynec surgery, Dr. Howard A. Kelly, and myself.

At the Atlanta meeting of this Association, in 1913,² I gave a brief description of the operation which I purpose describing more fully at this time.

The operation I have christened "shirring the round ligaments," since the designation describes to a nicety the procedure employed, as we shall see. The method is applicable only in those cases in which it is expedient to open the abdomen. For simplicity, ease of execution and efficiency, it surpasses any operation for the purpose I ever tried or saw published.

I shall make no attempt to discuss the indications for shortening the round ligaments, or to enter into the relative merits of the many types of operation employed for this purpose. I leave those questions for a subsequent occasion.

The illustrations make plain the succeeding stages and immediate results of the operation.

The first step, after having opened the abdomen and exposed the parts, is to seize the round ligament about midway with forceps (Fig. 1).

* Read before the Southern Surg. and Gynec. Assn., December 15, 1915.

¹ Transactions, North Car. Med. Society, 1907, p. 168.

² Transactions, Southern Surg. and Gynec. Assn., 1913, p. 85.

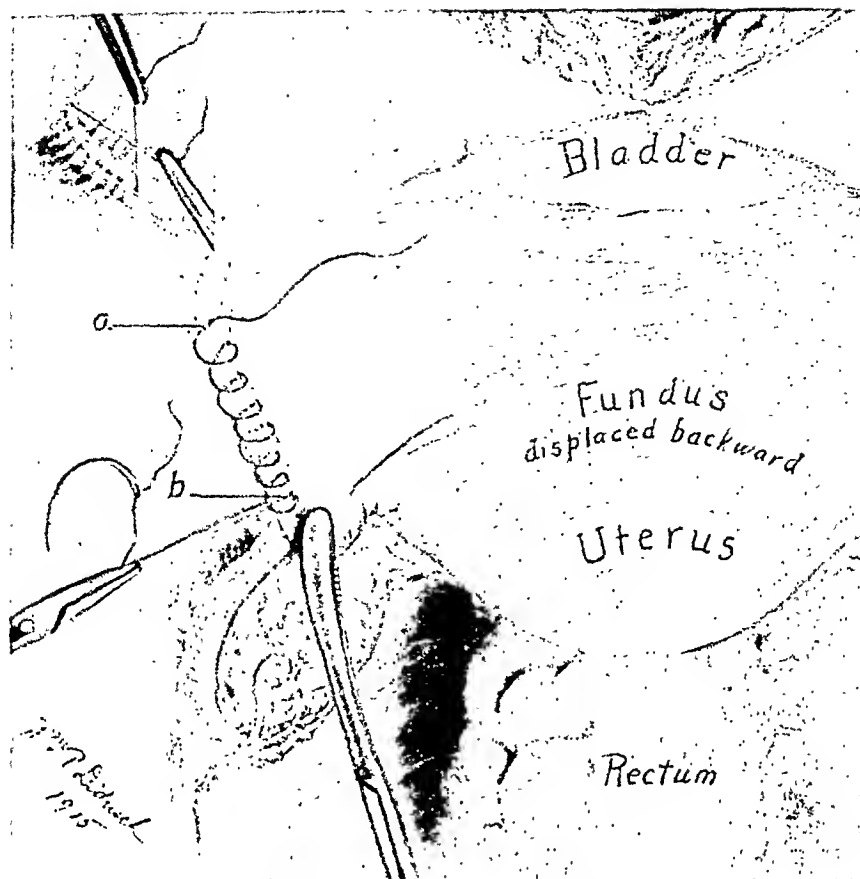


FIG. 1.—Shirring the round ligaments.

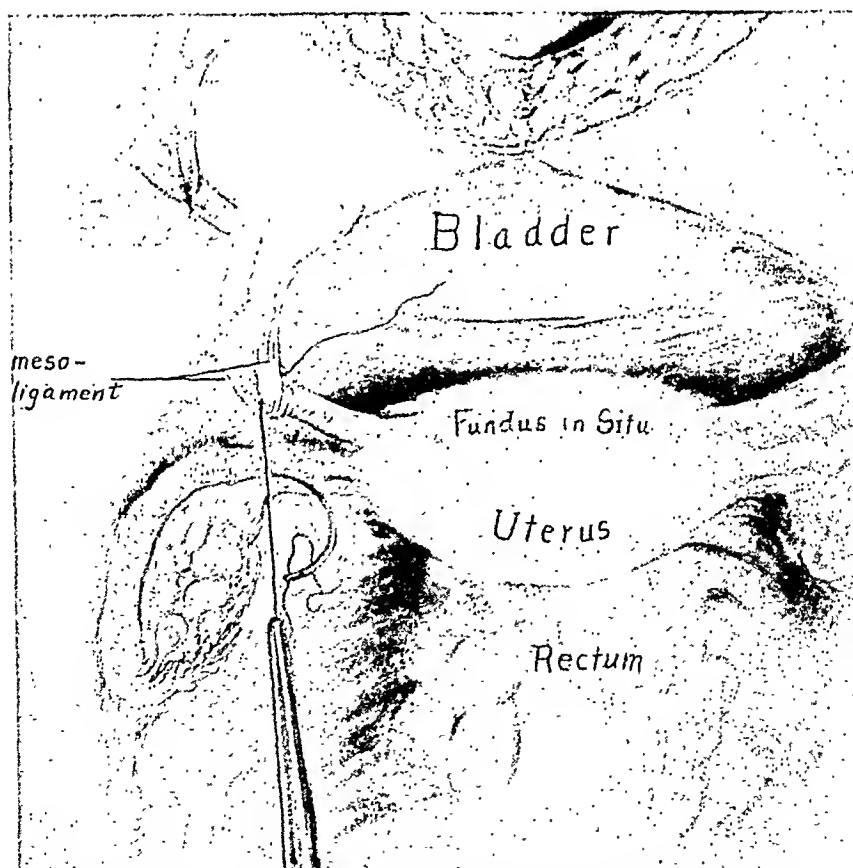


FIG. 2.—Shirred portion of ligament covered with mesoligament.

The exact point at which to catch the ligament is determined by estimating the amount of slack to be taken out of the ligament. On making traction upon the distal portion of the ligament with the forceps, from a half inch to an inch of the ligament will be pulled out of the inguinal canal. This is an essential part of the operation, as the sequel will show.

While tension is being kept up, a round needle, armed with linen or silk, is thrust through the ligament close to the pelvic brim, just at its exit from the internal inguinal ring (*a*). The needle is again put through the ligament about a quarter of an inch farther toward the fundus. This is repeated again and again, until sufficient length of the ligament has been sutured to insure the proper degree of shortening. The last puncture of the needle is usually made through that portion of the ligament which is traumatized by the bite of the forceps.

By pulling ever so lightly upon the ends of the suture the ligament begins at once to "shirr," as a dress-maker would say. This is seen distinctly in the insert. Shirring the ligament necessarily shortens it. You will observe that the points indicated by *a* and *b*, representing the extremes of the sutured portion of the ligament, approach each other. When the knot is tied it hugs up closely against the internal inguinal ring. If, perchance, sufficient of the slack in the ligament has not been taken up to tilt the fundus forward, one or more sutures can be introduced through the ligament, travelling always toward the uterus. The same needle and suture are used throughout the entire operation.

The operation might well be stopped here. In fact I had performed it many times before noticing that after tying the knot, gentle traction upon the suture develops a tiny *mesoligament* (Fig. 2). The base of this pseudomesentery springs from the pelvic wall. The major portion of it lies in front of the round ligament. This discovery gave me an idea; namely, that the peritoneal fold forming the mesoligament might be utilized as a cover for the shirred portion of the round ligament.

On trying out the suggestion I found it to be readily accomplished and with most satisfactory results. Catching the edge of the little meso with forceps it is pulled inward over the shirred portion of the ligament. While the meso is held in this position the same needle we started out with, armed with the same suture still uncut, is thrust through the mesoligament from below upward and another knot tied. Could anything be simpler? A little skill displayed here will hide even the last knot. I asked the artist, Mr. Didusch, to let the knot show in the illustration so that its position might be seen. The shirred portion of the ligament is hid entirely from view, and, what is better, out of reach of a troublesome intestine seeking an adhesive alliance.

The operation as finished evinces a refinement of technic that appeals to the most æsthetic surgeon. It is also so exceedingly simple that a well trained operating-room nurse could perform it, under the guidance of the surgeon, of course.

I have employed the operation for three years or more. Having demonstrated to my own satisfaction both its feasibility and efficiency, I feel, in newspaper parlance, that it is time it should be "released for publication."

URETHROPLASTY AT THE BASE OF THE GLANS PENIS*

BY COURTNEY W. SHROPSHIRE, M.D.

OF BIRMINGHAM ALA.

VISITING GENITO-URINARY SURGEON TO THE HILLMAN, ST. VINCENTS HOSPITAL AND THE BIRMINGHAM INFIRMARY

AND

CHAS. WATTERSTON, M.D.

ONE of the most troublesome conditions with which the surgeon has to deal is fistula along the course of the male urethra, and any means which science can devise for its relief will, we feel sure, be welcomed by the members of the medical profession as well as their patients.

The most delicate part of the male urethra, as far as perforating wounds are concerned, is at the base of the glans penis, for in this locality the urethra is hardly thicker than a sheet of writing paper, the essential structures being skin and mucous membrane. In addition to the weak physical structure the anatomic structure favors infections of a destructive nature, through inflammation of the peri-urethral glands internally, some of which open into the urethra at this point, and by means of infectious material being deposited during intercourse in the deep sulcus which presents on either side of the frænum externally.

In the course of urethral infections the peri-urethral glands can often be palpated between the thumb and index fingers at the base of the glans penis, the tumor ranging from the size of a grain of wheat to the size of a marble. The abscess can be opened into the urethra by means of a urethroscope or spontaneous rupture may take place into the urethra, the abscess cavity drained, and the condition be removed.

A certain percentage of these abscesses will open on the surface of the penis to the right or left of the frænum, perhaps on both sides, leaving a sinus so small as not to be noticed by physician or patient. Again, the inflammatory process may cause considerable destruction of tissue, with a resulting fistula ranging in size from three to twelve millimetres or more in diameter.

Externally, a syphilitic chancre often penetrates into the urethral canal near the frænum, in fact, it has been our experience that a chancre will in most cases penetrate the urethra if situated in the sulcus to the side of the frænum, unless treated energetically from the beginning.

* Read before the Jefferson County Medical Society, Birmingham, Alabama.

Fistulæ would be placed more under the head of troublesome than dangerous conditions, for there is little likelihood of their being the direct or predisposing cause of a severe lesion, but they are mutilating and brand a man as having been a sufferer from venereal disease, and we do our patients an injustice when we allow them to leave our care without this deformity being corrected.

The actual and apparent size of these fistulæ will vary greatly. A fistula not more than two or three millimetres in diameter on examination, will at operation have a ring of scar tissue surrounding it which must be removed, making the opening much larger. Our experience has been that it is practically useless to attempt to close these openings in the urethra by means of a purse-string or interrupted suture, unless we reinforce it with a plastic flap, for they invariably break down and the fistula is larger than it was previous to operation.

The following simple operation has given the best results in our work:

The urinary tract is rendered free of disease and some urinary antiseptic is administered for several days prior to operation. The parts are then cleansed and a straight sound passed into the urethral canal beyond the fistulous opening. The foreskin is now retracted by an assistant and an island of mucous membrane is marked off with its base toward the fistula opening, continuous with the mucous membrane of the urethra. This island should be slightly larger than the fistula to be closed. All scar tissue is now removed from the edges of the wound and a surface about one centimetre in width is denuded around the fistulous opening and the island of mucous membrane which has been preserved. A silk suture of the Halstead type is now placed in the outer edge of the denuded surface immediately above the fistulous opening. This suture is used as a retention suture and should be of medium silk doubled. The ends are now passed through the plastic flap in such a way as to bring the island of mucous membrane into the fistulous opening when they are tied (Fig. 1, C, suture No. 1). Other sutures of the Halstead type are placed so as to completely surround the wound at the outer edge of the denuded surface, the ends being passed through the flap but not tied (Fig. 1, C, sutures Nos. 2, 3, 4, and 5). A second row of sutures are now placed around the opening similar to the above, but on the inner edge of the denuded surface; these ends are also passed through the flap.

While these sutures are being inserted an assistant should control oozing as much as possible by means of hot packs applied to the denuded surface.

URETHROPLASTY AT BASE OF GLANS PENIS

The retention suture is now tied—not too tightly—this being followed by the tying of the other sutures passed through the flap (Fig. 1, D). The sound is removed, a rubber retention catheter placed in the bladder, and the patient put to bed.

The following case histories will illustrate the usual cause and treatment:

CASE I.—W. M., male, aged forty-seven, constable, referred by Dr. Spencer.

Three weeks ago the patient noticed a small sore on the right side of the frænum, which rapidly grew worse even though washed and dressed twice daily. Called on Dr. Spencer and was referred to us for treatment. Examination revealed a sore on right side

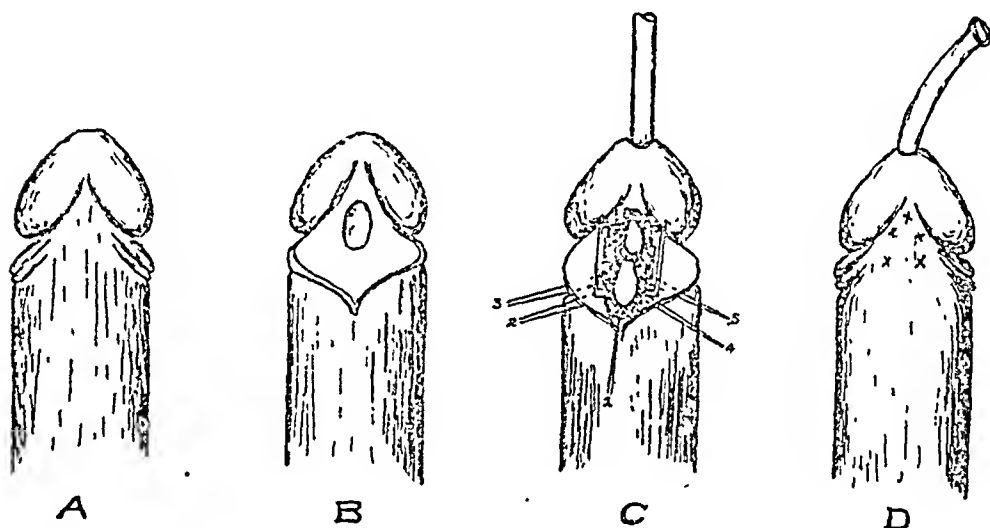


FIG. 1.—A, normal penis; B, fistula with destruction of frænum; C, sutures *in situ*; D, sutures tied.

of frænum which involved lower part of same, extended to opposite side, and entered urethra. Dark field examination *Spirochæta pallida*. Patient was given four intravenous injections of salvarsan, 0.3 to 0.6 Gm. to the dose, followed by mercurial treatment. Two months later Wassermann reaction negative. Operation at Birmingham Infirmary December 15, 1915, urethroplasty, using foreskin flap, restoring normal outline of penis. On the third day after operation patient was given 0.3 Gm. of salvarsan to destroy any organisms that may have been released by cutting into old scar. Results, primary union, patient left hospital on tenth day. Penis looks normal.

This case is interesting for the following reasons:

First, the size of the fistula which would easily admit the end of the index finger.

Second, the fact that the frænum was completely destroyed before the chancre healed, rendering operation more difficult.

Third, the wound healed by first intention when the tissue operated on had recently been the site of syphilitic sore.

CASE II.—J. D., male, aged thirty-five, telegraph operator.

Gonorrhœa five years ago with peri-urethral abscess opening to left of frænum. Examination revealed small fistulæ about three millimetres in diameter. Operation, July 5, 1915, resulted in complete recovery, slight scar remaining.

In conclusion we wish to say that in doing this work the following points should be observed:

First, have the urethral tract free of disease.

Second, control oozing as much as possible with hot packs.

Third, place all sutures with lower part U parallel with long axis of penis.

Fourth, do not tie sutures too tightly.

Fifth, wash bladder through catheter with saturated solution of boric acid daily.

Sixth, remove the catheter every other day and irrigate the urethra, without distention, with solution of boric acid. Do not use a mushroom catheter.

Seventh, dress wound by painting with tincture of iodine, three per cent., on third day, remove catheter on seventh day, and have patient drink half gallon of water daily, beginning as soon after operation as possible. Take out first sutures on fourth day and remove retention suture last, on tenth day.

THE PATHOLOGICAL DIAGNOSIS OF DISEASES OF THE APPENDIX BASED ON THE STUDY OF 1500 SPECIMENS

BY ELI MOSHCOWITZ, M.D.

OF NEW YORK CITY

PATHOLOGIST TO BETH ISRAEL HOSPITAL

(From the Pathological Laboratory of Beth Israel Hospital.)

My purpose in this paper is twofold. First, to try to clarify, if I may venture to say so, some of the current notions concerning the pathology of appendicitis; and second, to demonstrate and establish definite criteria by which disease of this organ may be recognized. The classical monograph of Aschoff on the pathology of appendicitis covers the ground so fully as to almost prohibit any further contribution to this subject. Unfortunately, Aschoff's work seems to be known largely by title only, as any one conversant with the current notions of the pathology of appendicitis can testify. Witness, for instance, the remarkably confused terminology of this disease. The terms, catarrhal, both acute and chronic, gangrenous, ulcerative, and perforative appendicitis are employed with a looseness that displays altogether insufficient acquaintance with the meaning of these terms and their relationship to inflammations of the appendix. Furthermore, these terms are conventionally employed to connote different maladies, with only a vague notion that they represent phases of a single pathological process.

As an inevitable consequence of this vagueness concerning the pathology of appendicitis, the gross diagnosis, as to whether the removed organ is diseased or not, leaves much to be desired, from the average surgeon's view-point; and if his instinct, if you may call it such, leads him to pronounce the appendix diseased, he is frequently unable to indicate his reasons therefor. To recognize that an appendix is diseased or normal, the microscope, as I shall show, is by no means always necessary. I believe that in 90 per cent. the diagnosis of a present or previous appendicitis may be easily recognized by the naked eye.

In the first place, I hold that the conventional method of longitudinally slitting the organ to determine if and to what extent the appendix is diseased, is wrong. Obliterations and strictures are sometimes overlooked in this way because the trauma often destroys the lumen, so that we are unable to tell what is lumen and what is obliteration. In acute appendicitis, the longitudinal method is not so apt to lead to mistakes,

but it does not enable us to diagnose with as much accuracy the duration of the lesion as by the method I recommend. This method consists in simple transverse incisions made at various levels. By such incisions we are able to tell accurately the quantity and topography of the exudate; the width and conformation of the lumen; or whether there is a lumen at all; the relation of the mucosa to the muscularis, which, as I shall show, is an important diagnostic item; and, finally, the extent of the infiltration of the coats. The objection may be raised that by transverse incisions we may miss a lesion. This I have not found to be valid; first, because the vast majority of lesions of the appendix are found in the terminal portion; and second, because the lesions, as a rule, are simple, extend over a broad area, and have some external deformity to serve as guide.

My own contribution to this subject, aside from my attempt to popularize Aschoff's teachings, is: first, to afford a systematic interpretation and exposition of the disease, so that the lesion may be more easily recognized grossly; second, to add a number of new diagnostic features to the pathogenesis of appendicitis; and third, to correlate, as far as my opportunities have allowed me, the lesion with certain clinical phenomena.

I have purposely avoided any discussion of certain of the gross lesions of the appendix, such as kinks, adhesions, etc., for the reason that such lesions are no longer present when the specimen is referred to the laboratory for examination. This omission does not imply that I do not concede the profound importance of these lesions in the etiology of appendicular disease.

Normal Appendix.—The appendix varies widely within normal limits, as regards size, shape of lumen, number of crypts, abundance of lymphatic apparatus and thickness of muscular coats. Some of these variations are dependent upon age; appendices in the young, for instance, being richer in lymphatic apparatus than in the adult. But the other variations do not appear to depend upon any other factor.

Figure 1 (3742), however, presents the sectional appearance of an average normal appendix. Note that the lumen contains four crypts lying between corresponding projections of mucosa. The lumen is lined by the high cylindrical epithelium peculiar to the intestinal tract; the epithelium forms glands which are most abundant in the projections of the mucosa, becoming less in number as we approach the bases of the crypts. The stroma of the mucosa is rich in lymphatic tissue in certain places, especially within the projections and around the base of the mucosa, this tissue is more compactly arranged and embraces a more translucent round area containing larger lymphoid cells, the so-called "chyme centres." The lymphoid tissue is identical in structure with the other lymphoid tissue of the body, such as the lymph-glands, tonsil, etc.

Between the mucosa and the muscularis is a rather narrow zone consisting of fibrous areolar tissue, fat tissue, blood and lymphatic vessels and a sparse scattering of round lymphoid cells. I lay special stress upon the width of this submucous zone because, as we shall see, its width is an important diagnostic point in the gross diagnosis of certain forms of chronic appendicitis. Proceeding outward, we find the two muscular layers of the appendix, embracing within their muscle fibres groups of sympathetic ganglion cells. Beyond this is the narrow zone of subperitoneal connective tissue, containing many blood- and lymphatic vessels. Finally, we come to the peritoneal coat consisting of a delicate single layer of endothelium. The lumen of the appendix is empty or contains a small amount of faeces and traces of mucus; the mesentery of the appendix consists of fatty tissue and many blood- and lymphatic vessels, which penetrate the muscular coats of the appendix.

Acute Suppurative Appendicitis.—Fig. 2 (3784). Lesion during first twelve to twenty-four hours.

The type of lesion represented in this figure is the primary lesion of all forms of appendicitis, just as the chancre is that of syphilis. *Appendicitis begins in no other way than as here represented.* The genesis of this lesion furthermore forms the keynote to the interpretation of the pathological anatomy of every lesion of the appendix, both acute and chronic. I shall therefore describe this lesion in detail.

First, we note that from the bases of two of the crypts, there spring forth two projections of membrane or exudate, containing fibrin and many pus and red blood-cells, which meet in the centre of the lumen. Note also that the epithelial lining is completely absent at the bottom of the crypts so that the membrane of the exudate appears continuous with the lymphoid stroma. On the other hand, although the exudate spreads to the very base of the remaining crypt of the appendix, the epithelial lining in this crypt is nevertheless intact, showing that the exudate did not originate there. We note also the dilatation of the blood-vessels within the mucosa, most marked at the prominences. The submucous, muscular and subperitoneal connective tissue coats are already infiltrated with numerous polymorphonuclear lymphocytes, while the subperitoneal blood-vessels are markedly injected. Note that a well defined peritonitis is already present. The endothelial layer is completely absent and the surface is covered by a thin layer of exudate, of the same morphology as that within the lumen.

I emphasize the early appearance of a localized appendicular peritonitis because it is not generally appreciated that a local peritonitis is already present in the early stages of the disease. I have never seen an appendix acutely inflamed that did not show this lesion, although I confess that I do not recall ever having examined an appendix removed in the first twelve hours after the onset of symptoms. *Without any further evidence, therefore, the absence, even grossly, of a localized appendicular peritonitis, practically excludes an acute appendicitis.*

I also call attention to the entire freedom of the lymphatic apparatus from the infective invasion. These structures have a peculiar immunity in all acute inflammations of the appendix and are the last

structures to be destroyed by the infective process. The mesenteriolum is normal.

Twelve to Twenty-four Hour Lesion.—Fig. 3 (3183). This lesion is slightly more advanced than the preceding. The membrane is more extensive and fills up almost the entire lumen of the mucosa. The destruction of the lining epithelium has become so extensive that it persists only over the prominences of the mucosa. The infiltration of the coats with polymorphonuclear cells is more extensive, so that it is more difficult to distinguish the muscular coats. The mesenteriolum is also extensively infiltrated with pus-cells and the blood-vessels are injected. There is a well-marked peritonitis.

Twenty-four to Forty-eight Hour Lesion.—Fig. 4 (3108). This specimen represents a still more advanced process. The exudate now completely fills the entire lumen. The mucosa has been completely destroyed except for two small projections on one side. The lymphatic apparatus now shows purulent infiltration. Many of the lymph-vessels in the submucosa are filled by polymorphonuclear cells (lymphangitis). There is extensive oedema of the muscular coats. The infiltration of the coats with polymorphonuclear cells is very extensive. Localized peritonitis.

Twenty-four to Forty-eight Hour Lesion.—Fig. 5 (3046). A still more advanced lesion. The exudate has now partly broken down leaving a rather large lumen. The mucosa is still represented by a small prominence upon one side. Scattered throughout the exudate are colonies of bacteria. Remains of the lymphatic apparatus are still noticeable near the base of what once was the mucosa. The infiltration of the muscular coats is so extensive that their definition is difficult. The remaining lesions are the same as the preceding.

Forty-eight to Seventy-two Hour Lesion.—Fig. 6 (3183). A still more advanced stage. The mucosa has now completely disappeared. The faint staining, absence of nuclei and karyorrhexis in the exudate indicate a profound necrosis. The purulent infiltration of the muscular coats is now so extensive as to completely mask the histological structure. Otherwise the lesions are those of the preceding.

Lesion of Forty-eight or More Hours.—Fig. 7 (3106). Complete necrosis of all coats of appendix.

Perforation.—Fig. 8 (3689). The appendix shows the changes associated with a long duration—forty-eight to seventy-two hours. The mucosa is completely destroyed and the lumen filled up with exudate. On one side we note a broad space where the walls of the appendix are absent; this space is filled by a plug of exudate continuous with that in the lumen. Attention is called to the mesentery which, while extensively infiltrated with pus-cells, shows no thrombosis.

Comment.—This is the typical pathological picture in acute perforations of the appendix. It is evident that the process is not a peculiar one, but incident to the same acute suppurative process above described. Acute perforations are, in my opinion, due to the direct destructive action of the bacteria upon the wall of the appendix, associated with extensive tension on the part of the exudate within the lumen. I believe thrombosis

PATHOLOGY OF APPENDICITIS

of the mesenteriolum plays little rôle in its etiology, because I have never found it in such cases.

All the perforations of the appendix I have studied are associated with the characteristic lesions of the later stages of the disease, when the entire circumference of the mucosa has been completely destroyed and the infiltration of the walls is very profound. I realize full well, that perforations have been found in the first twenty-four hours of the malady, but as yet I have not seen it in the laboratory. In passing, I may say that perforations of the appendix are at present uncommon, due, probably, to early operations.

Empyema of the Appendix.—Fig. 9 (6262). The lumen is enormously dilated. The superficial epithelium of the mucosa is completely absent; that of the glands is degenerated and extensively desquamated. The stroma of the mucosa is congested and œdematous; the lymphoid apparatus is intact. All the remaining coats show extensive infiltration with polymorphonuclear leucocytes. The peritoneum, however, shows no fibrin covering, indicating that there is no acute peritonitis.

Comment.—This picture, while resembling in many particulars that of the lesion of acute suppurative appendicitis, is nevertheless quite different. There is no formation of exudate and in consequence no profound necrosis and ulceration. The ulceration is superficial and due entirely to the loss of epithelium. Furthermore, there is no acute peritonitis, a phenomenon, as I have shown, incident to practically every acute inflammation of the appendix.

How, then, are we to interpret this lesion? The facts are that this section was taken from a hugely dilated bulbous tip of the appendix. At the neck of this bulb the appendix revealed a typical acute suppurative appendicitis. The pus formed in this area flowed into the bulbous tip, creating a so-called empyema. The changes in the mucosa, just described, are due entirely, in my opinion, to the notorious fermentative action of the purulent contents, and not to bacterial infection. The infiltration of the coats with polymorphonuclear leucocytes is probably more the accompaniment of the acute suppurative inflammation above, rather than the result of irritant action from the immediate mucosa. This surmise is rendered more probable by the absence of localized peritonitis.

This lesion is typical in my experience of empyema of the appendix. In other words, an empyema of the appendix is usually the result of a secondary purulent collection within a previously formed dilatation of the appendix, rather than a primary suppuration and consequent breaking down of an acute suppurative appendicitis. Very often, also, the acute suppurative lesion heals; the purulent collection in the dilated

portion remains, and usually causes sufficient irritation to demand removal of the organ. This is why empyemata of the appendix are commonly found in interval operations. On the other hand, I have seen true empyemata occurring in dilated appendices, in which the lesion was precisely that of acute appendicitis.

Mesenteriolum.—In every acute appendicitis there is profound infiltration of the fatty tissues of the appendix with polymorphonuclear leucocytes; this infiltration becomes progressively more extensive the longer the duration of the illness. It is difficult to determine the presence or absence of thrombosis of the mesenteriolum by microscopic examination, for the reason that histologically it is practically impossible to determine whether the thrombus is ante- or post-operative. Of course, I refer only to early thrombi. I have seen but one case of late thrombosis, occurring in a case of pyelophlebitis of the portal vein.

Summary of Acute Suppurative Appendicitis.—The pathological anatomy of acute appendicitis, as I have attempted to picture it, leads to many reflections.

1. It affords every ground for presuming, as Aschoff insists, an enterogenic as opposed to a hæmatogenous infection of the organ. This is evidenced by the invariable origin of the lesion from the mucosa. I have never seen an acute local infection of any of the tissues of the appendix unassociated with the mucosal lesion that I have described, a phenomenon that manifestly excludes a hæmatogenous origin of appendicitis. This is a rather broad statement, since a hæmatogenous origin for acute appendicitis has often been seriously held; but I believe this contention is sound.

2. The lesion of acute appendicitis is *not* a catarrhal inflammation as understood in the pathological sense. Indeed, *acute and even chronic catarrhal inflammations of the appendix do not occur*. The term "catarrhal" inflammation as far as the appendix is concerned, therefore, is a misnomer and should never be employed.

3. Can we interpret the pathogenesis of acute appendicitis in terms of lesions here described? I believe all we can safely assert is, that it is a bacterial infection and that the lesion starts in the crypts because stagnation is more likely to occur in these areas. The fact that approximately nine-tenths of the lesions of acute appendicitis occur at the tip of the appendix, where stagnation is most apt to occur, lends support to this hypothesis. This fact also makes untenable the contention, advanced by some, that appendicitis is occasionally due to a cæcitis or lesion of the so-called Gerlach's valve, thus interfering with the drainage of the organ. The lesions obviously throw no further light upon the

direct etiology of acute appendicitis. The necrosis of the walls or, as conventionally termed, the "gangrene," is, to my view, largely due to the action of bacteria; thrombosis of the blood-vessels in the mesenterium is altogether too uncommon a lesion to be a large factor.

4. The pathological lesion fairly corresponds to the duration of the illness, as I have tried to show. But it is not uncommon to cut appendices in which we find various stages of the process, from the earliest to the more advanced. This simply means that the infective process starts at one point and spreads gradually to other points. I have never seen this spreading occur except by direct continuity.

5. The lesion of acute appendicitis is a membranous inflammation or, more familiarly termed, a diphtheritic inflammation. This type of inflammation need not be regarded as peculiar to the appendix, because a membranous inflammation is the rule in all of the acute inflammations of the mucous membranes of the body. Nothing, for instance, can be more striking than the absolute identity of the lesions of both acute follicular tonsillitis and acute appendicitis. In tonsillitis, the crypts, corresponding to the sulci within the appendix, are filled with a membranous exudate; there is the same loss of epithelium in the crypts, the same comparative immunity of the lymphatic structures lying between the crypts and the same infiltration of the tissues. Thus far, however, the similarity ends, because acute tonsillitis nearly always ends in complete restitution of the organ, while in appendicitis, necrosis, and if recovery occurs, scar formation are frequent sequelæ. I can account for this only by the different circulations of the two organs, that in the tonsil being anastomotic, while in the appendix it is terminal.

The diphtheria caused by the Klebs-Löffler bacillus, acute cholecystitis, acute enteritis, typhoid fever, etc., have precisely the same pathological anatomy I have described for acute appendicitis.

6. *Onomatology*.—The characteristic feature of acute appendicitis is an infection and invasion by polymorphonuclear leucocytes, so that the term "acute suppurative appendicitis" from the pathological viewpoint is the one most applicable and covers every requirement. The conventional terminology of acute appendicitis is, as I have already remarked, both various and confusing. We often hear the terms "acute catarrhal," "acute gangrenous," and "acute ulcerative" appendicitis. These terms, however, are inaccurate, in the pathological sense. "Catarrhal appendicitis," as I have already shown, does not exist. The term "gangrenous" is one that offers a wide latitude in its interpretation; moreover, with the microscope it is often difficult and sometimes impossible to assert that the tissues of the appendix are dead beyond

hope of regeneration. The term "ulcerative" is bad because there is no loss of tissue, except in the terminal phases of the infection. For these reasons I plead for the conception of acute appendicitis as a suppurative process.

Healing Appendicitis.—Fig. 10 (2916). Upon one-half of the lumen, the mucous membrane is congested, but intact, and contains a large lymph centre. The remaining half is lined by a mass of young granulation tissue covered on its surface by partly necrotic exudate. There is still a small amount of comparatively fresh exudate within the lumen. At the junction of the two surfaces the surface epithelium from the intact mucosa has spread for a short distance to either side, upon the newly-formed granulation tissue. The walls of the appendix are œdematous and still show extensive infiltration with polymorphonuclear leucocytes, but in addition there are a large number of round and plasma cells. The fibrin on the peritoneal surface has almost completely disappeared, and has been replaced by a soft œdematous tissue that shows beginning organization. The peritoneal blood-vessels are injected.

Comment.—The lesion can be interpreted as follows. In this appendix the acute suppurative process was arrested comparatively early; before the entire mucous membrane was destroyed. The exudate that destroyed the remainder has broken down, leaving a comparatively broad ulcer which, as the granulation tissue indicates, shows unmistakable evidence of beginning healing. The lumen is in the process of restoration by an extension of epithelium proceeding from the intact mucosa over the base of this ulcer. Further evidences of healing are the disappearance of polymorphonuclear leucocytes in the walls, the appearance of round and plasma cells, and the beginning organization of the peritoneal exudate.

Fig. 11 (2967). This appendix reveals a somewhat later stage of the healing process. On one side of the small lumen a very small area of intact mucosa is seen. The remaining part of the wall of the lumen is lined by a richly cellular granulation tissue. The surface epithelium, as in the previous specimen, has already spread along the surface of this new granulation tissue for a considerable extent. Note the persistence of many foci of lymphatic tissue. The polymorphonuclear infiltration of the walls has almost completely disappeared. On the other hand, the muscle fibres are completely disorganized and the bundles are separated from one another by young new connective tissue. The peritoneal coat is very thick, œdematous, and shows a fairly advanced connective tissue organization.

Fig. 12 (2967). Another portion of the same appendix. In this area the mucosa has been completely destroyed, and the lumen is filled with characteristic new granulation tissue. Otherwise the lesion is the same as the preceding.

Fig. 13 (3205). This appendix represents a more advanced stage. The mucosa has been completely destroyed; the granulation tissue is firmer, as

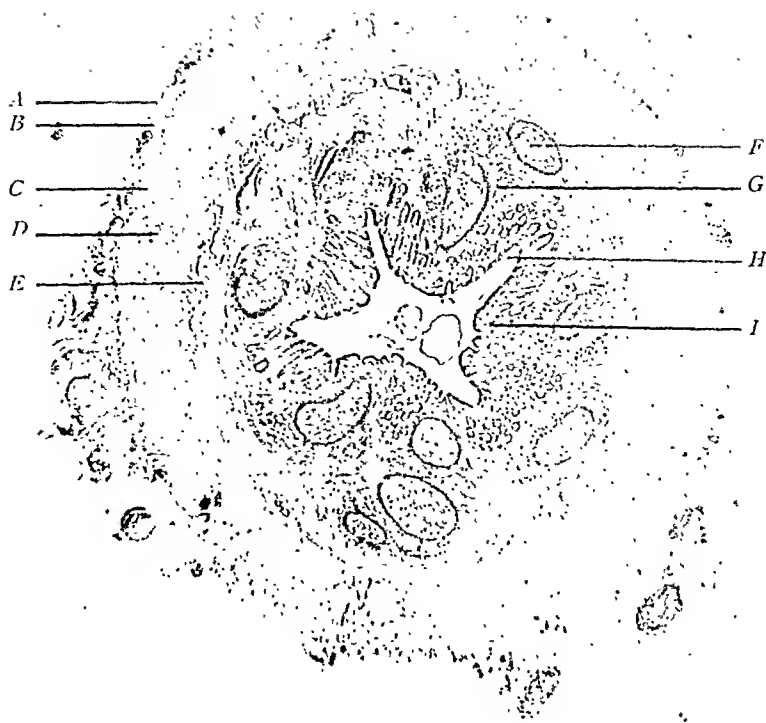


FIG. 1.—Cross-section of normal appendix. *A*, peritoneal coat; *B*, subperitoneal connective tissue; *C*, external muscular layer; *D*, internal muscular layer; *E*, submucous connective tissue; *F*, chyme centres; *G*, lymphoid tissue; *H*, crypts; *I*, mucosa.



FIG. 2.—Acute appendicitis; twelve- to twenty-four-hour lesion. *A*, mucosa, showing congestion and slight blood extravasation; *B*, masses of exudate springing from the crypts; *C*, base of crypt showing intact mucosa; *D*, muscular coats infiltrated with polymorphonuclear cells; *E*, fibrinous exudate covering peritoneum, *i.e.*, localized peritonitis.



FIG. 3.—Acute appendicitis, twelve- to twenty-four-hour lesion. A, intact mucosal prominences; B, exudate; C, submucous connective tissue infiltrated with polymorphonuclear leucocytes; D, muscular layers infiltrated with polymorphonuclear leucocytes; E, localized peritonitis.

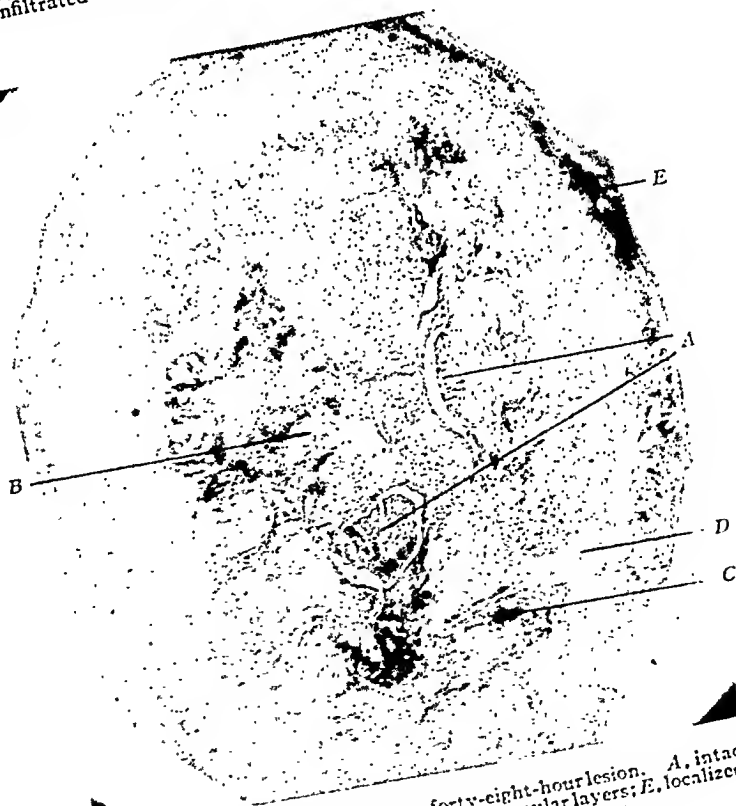


FIG. 4.—Acute appendicitis, twenty-four- to forty-eight-hour lesion. A, intact mucosal prominence; B, exudate; C, remnants of lymphoid tissue; D, muscular layers; E, localized peritonitis. All the coats are densely infiltrated with polymorphonuclear leucocytes.

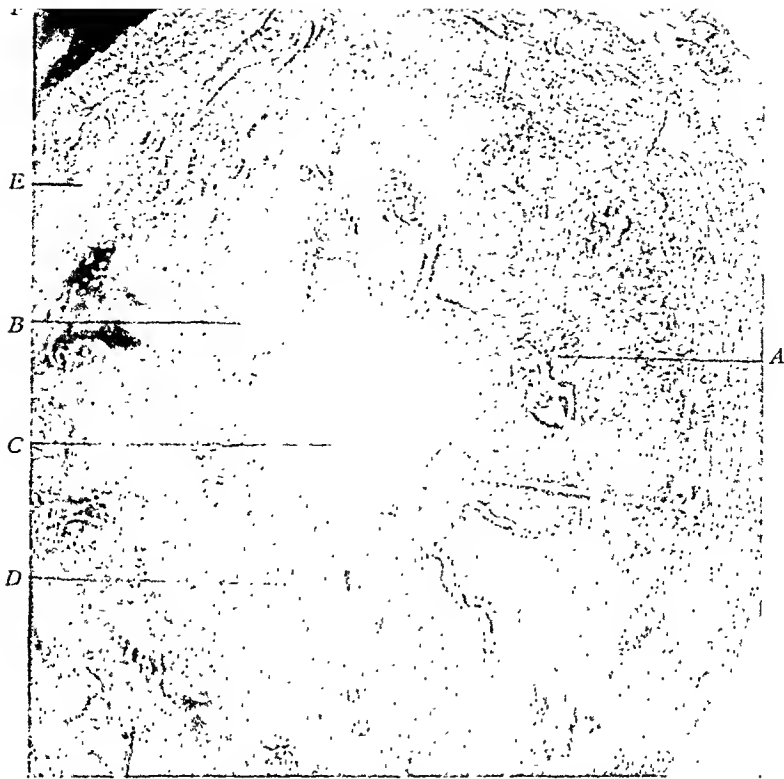


FIG. 5.—Acute appendicitis, twenty-four-to forty-eight-hour lesion. A, intact mucosal prominence; B, exudate which has broken down in the centre leaving lumen C; D, masses of bacteria; E, muscular layers so densely infiltrated with polymorphonuclear leucocytes that their definition is difficult; F, localized peritonitis.



FIG. 6.—Acute appendicitis, forty-eight-to seventy-two-hour lesion. A, exudate; B, muscular layers; C, localized peritonitis.

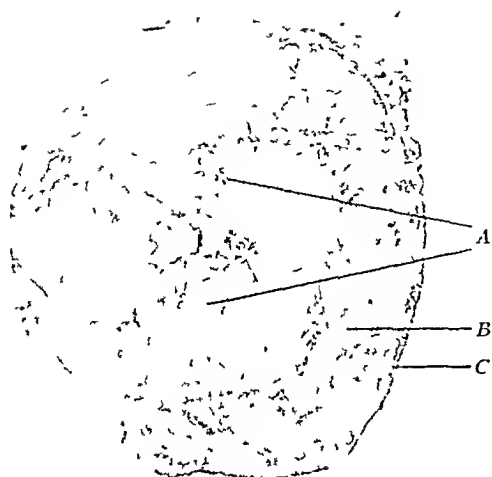


FIG 7 —Acute appendicitis, lesion of forty-eight or more hours. *A*, necrotic exudate, *B*, muscular layers almost completely necrosed, *C*, localized peritonitis.



FIG 8 —Acute appendicitis with perforation, late lesion. *A*, exudate, *B*, perforation, *C*, mass of fibrin blocking perforation, *D*, muscular coats.

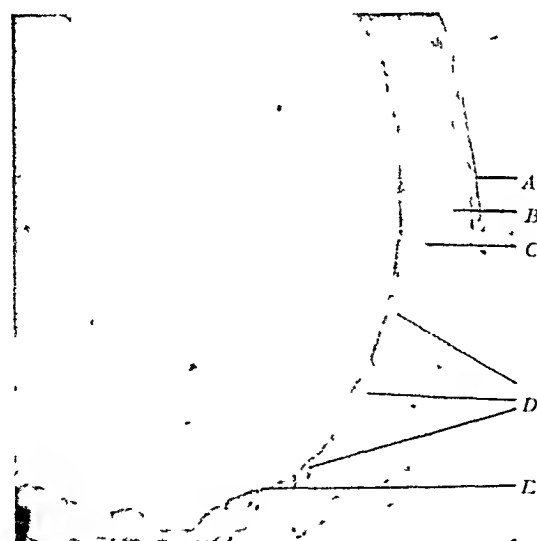


FIG 9 —Acute appendicitis, empyema of appendix. *A*, normal peritonium, *B*, muscular coats slightly infiltrated with polymorphonuclear leucocytes, *C*, intact lymphoid tissue, *D*, mucosal glands many of which show degeneration of the epithelium, *E*, lining epithelium almost completely absent.

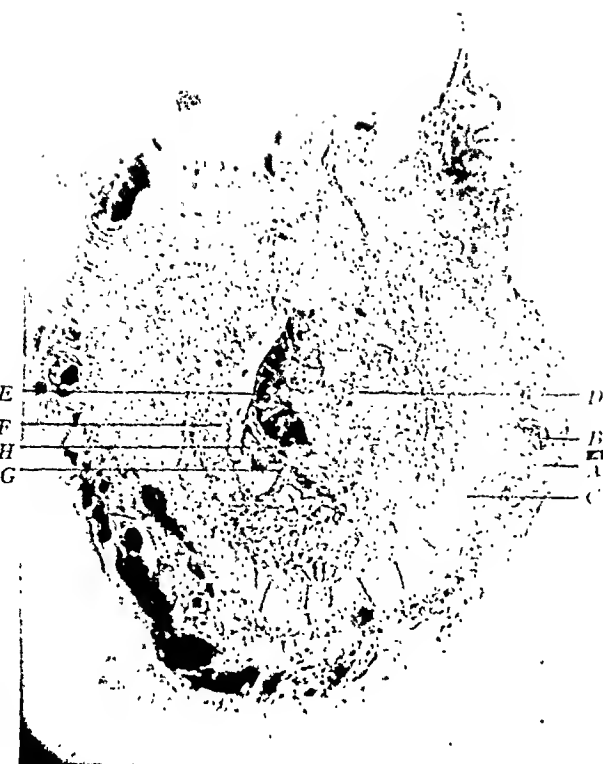


FIG. 10.—Healing appendix. A, peritoneal and subperitoneal coats showing connective tissue organization; B, dilated blood-vessels; C, muscular layer infiltrated with young connective tissue; D, infiltrated submucous coat; E, congested mucosa; F, base of broad ulcer consisting of granulation tissue; G, epithelium beginning to spread over lateral edges of ulcer; H, free exudate in lumen.

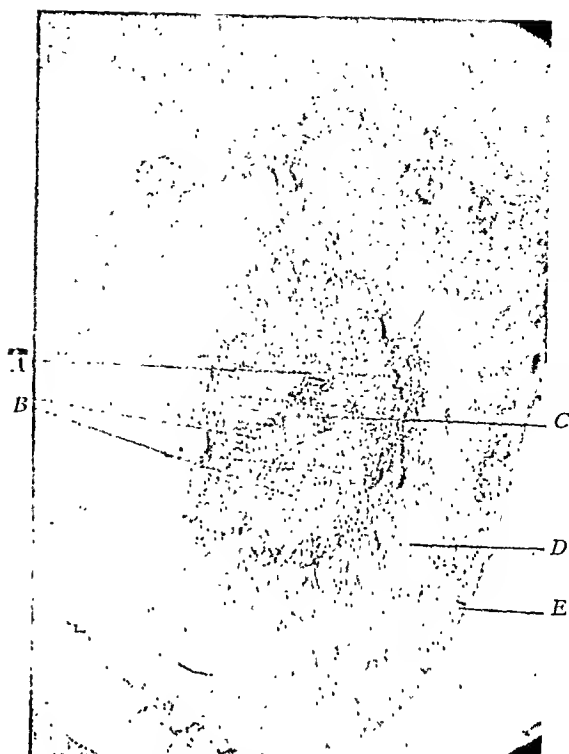


FIG. 11.—Healing appendix. A, small remnant of mucosa; B, granulation tissue filling lumen of appendix; C, exudate; D, muscular coats infiltrated with young connective tissue; E, organizing peritonitis.

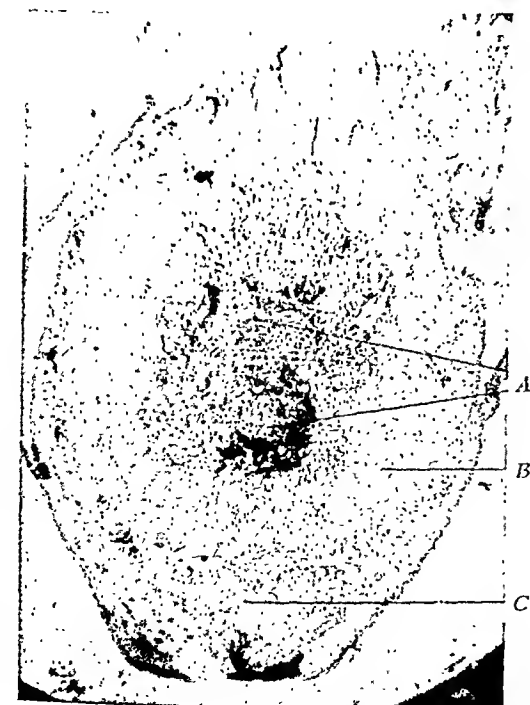


FIG. 12.—Healing appendix. A, granulation tissue; B, muscular coats showing fairly advanced connective tissue organization between the muscular fibres; C, organizing peritonitis.



FIG. 13.—Healing appendix. A, almost completely organized granulation tissue filling lumen of appendix; B, muscular coats infiltrated with the same tissue.

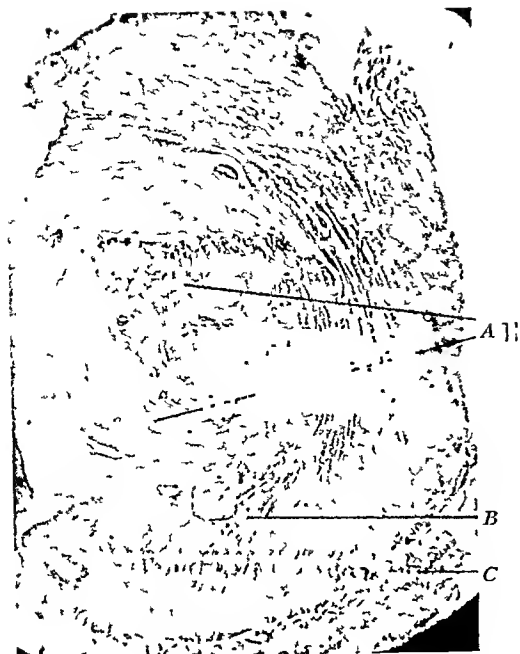


FIG 14 —Healing appendix A, almost complete tissue filling lumen, B, mucosa, C, broad submucous connective tissue zone, D, muscular coats infiltrated with new connective.

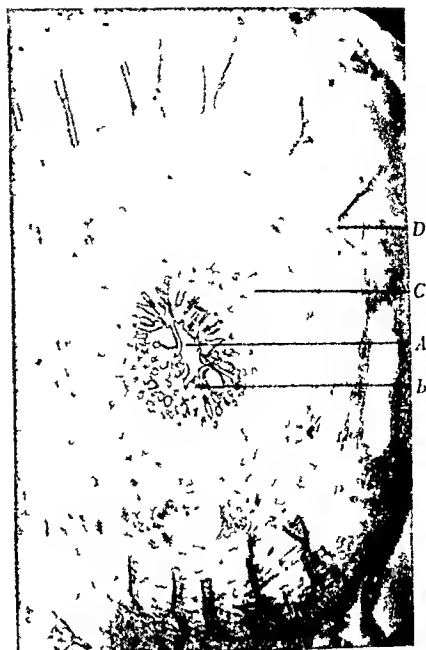


FIG 15 —Healed appendix, stricture A, small and almost cryptless lumen, B mucosa, C, broad submucous connective tissue zone, D, muscular coats infiltrated with new connective. Note sparseness of lymphoid tissue

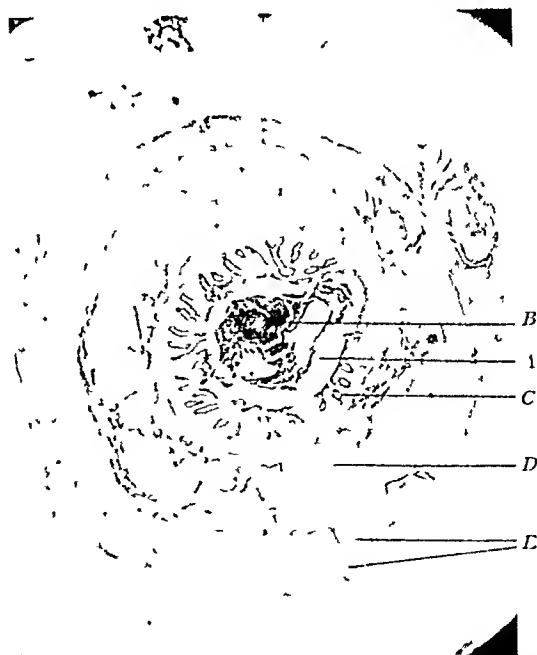


FIG 16 —Healed appendix stricture A, narrow cryptless lumen containing mucus and fresh blood, B; C, mucosa, D, broad and extremely attenuated submucous connective tissue zone; E muscular coats

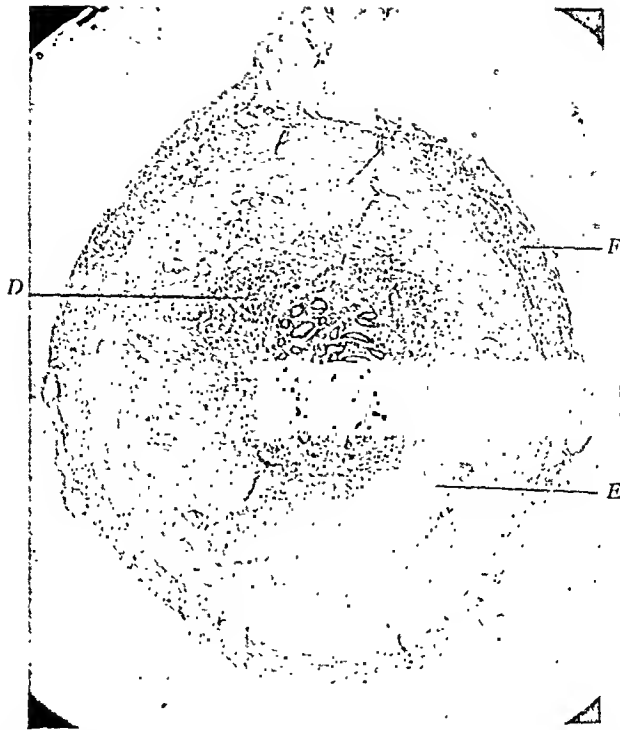


FIG. 17.—Healed appendix; stricture. A, small cryptless lumen; B, mucosa; C, dilated mucous gland; D, lymphoid tissue; E, broad submucosa; F, thinned muscular layer.

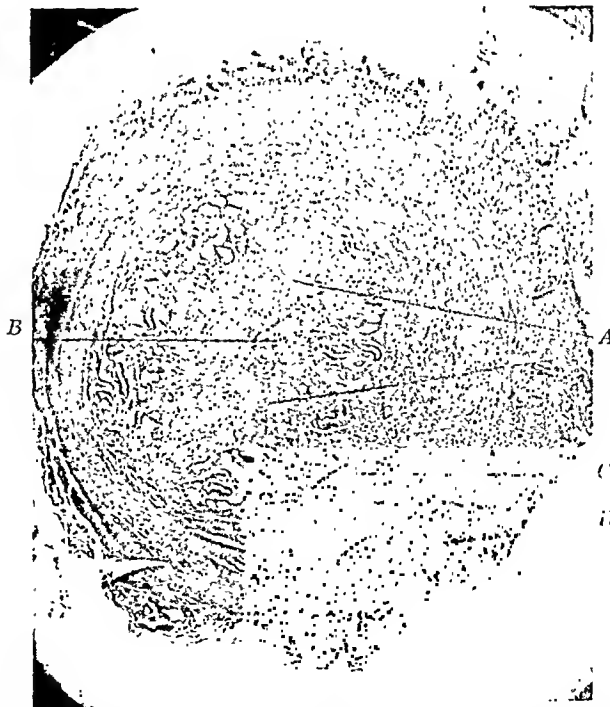


FIG. 18.—Healed appendix; obliteration. A, fibrous connective tissue filling lumen; B, remnant of lymphoid tissue; C, broad submucosa; D, deformed and infiltrated muscular coat.

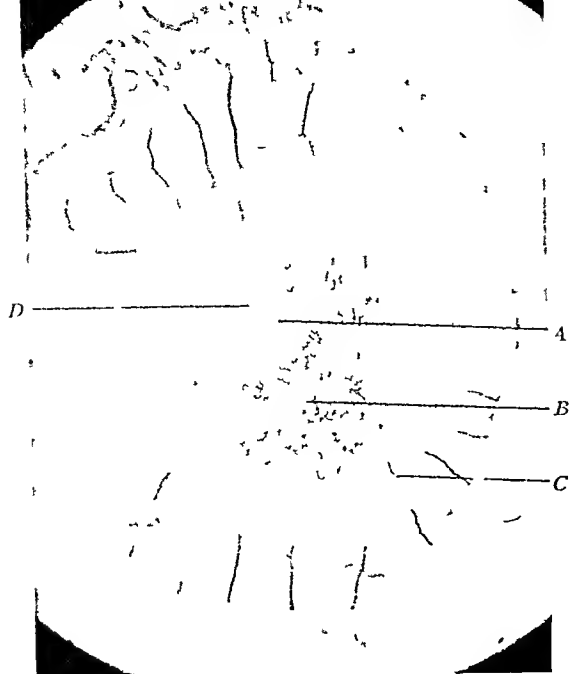


FIG 19—Healed appendix, obliteration. Firm fibrous tissue filling lumen *A*, broad submucous connective tissue zone, *C*, infiltrated and deformed muscular layers, *D*, remnants of lymphoid tissue

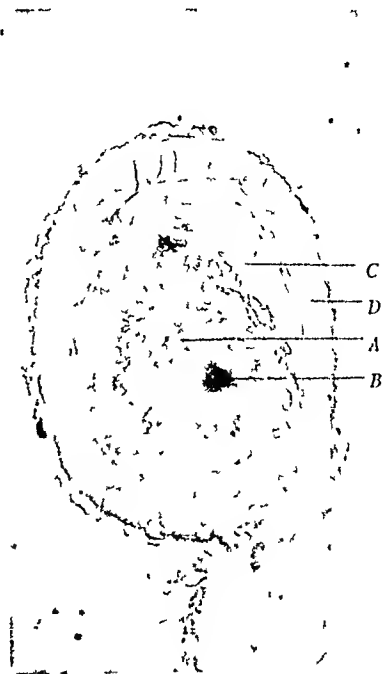


FIG 20—Healed appendix, obliteration. *A*, firm fibrous tissue filling lumen; *B*, remains of lymphoid tissue, *C*, broad submucous connective tissue zone, *D*, infiltrated muscular layers



FIG 21—Submucous traumatic hemorrhage in appendix. 1, mucosa showing blood extravasations, *B* lymphoid tissue, *C* submucous connective tissue zone, *D*, muscular layers



FIG 22—Submucous traumatic hemorrhages in appendix. *A*, mucosal blood extravasation showing penetration through the superficial mucosa, *B*, normal mucosa



FIG. 23.—Coprolith. *A*, coprolith, *B*, intact superficial mucosa. Note rubbing away in other portions. *C*, mucosal glands, *D*, lymphoid tissue, *E*, submucous connective tissue zone, *F*, thinned out muscular layers

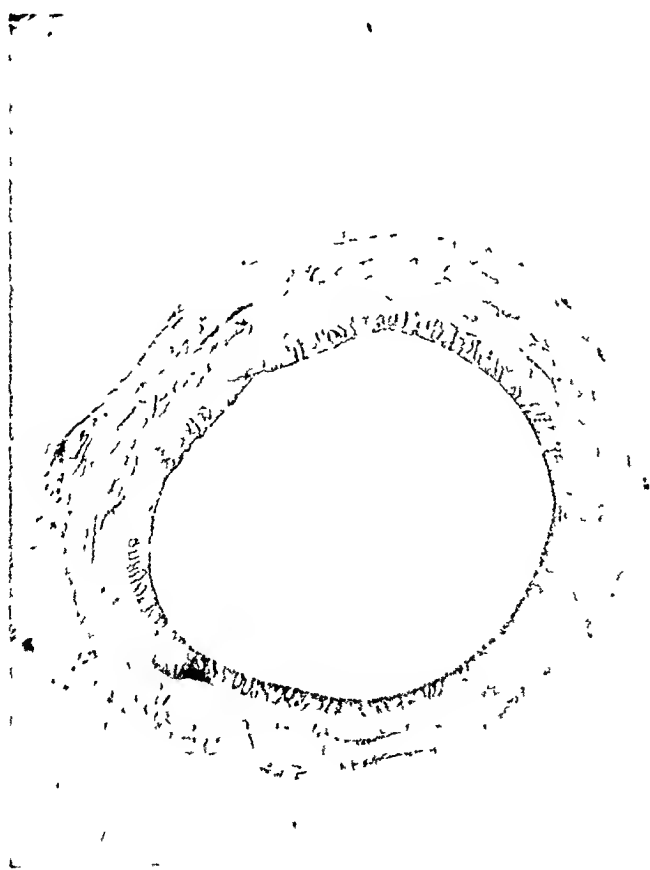


FIG. 24 —Appendix dilated from coprolith. Note intact lining epithelium.



FIG. 25.—Lymphoid hyperplasia of the appendix. A, chyme centres surrounded by masses of lymphoid tissue.

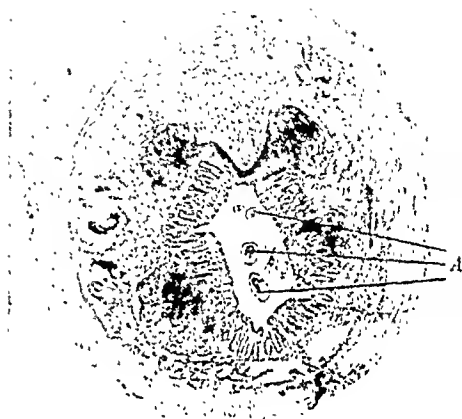


FIG. 26.—Oxyuris in appendix. A, cross-sections of oxyuris. Note intact mucosa. Appendix normal.



FIG. 27.—*Trichocephalus dispar* in appendix. A, cross-section of trichocephalus partially imbedded in superficial epithelium; B, fresh blood in lumen.

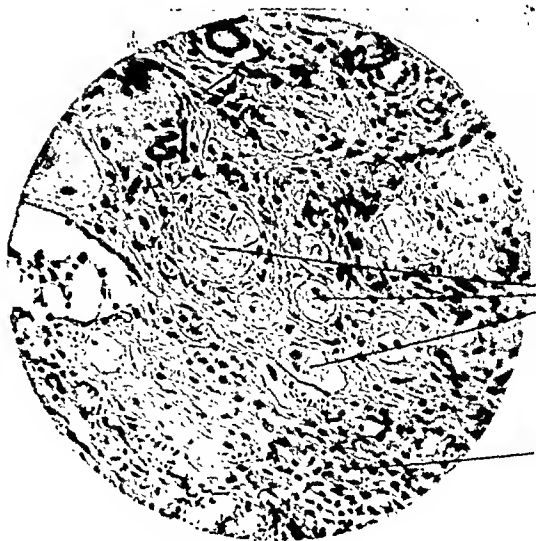


FIG. 28.—Decidual reaction of subperitoneal connective tissue (high power). A, decidual cells; B, normal round-cells.

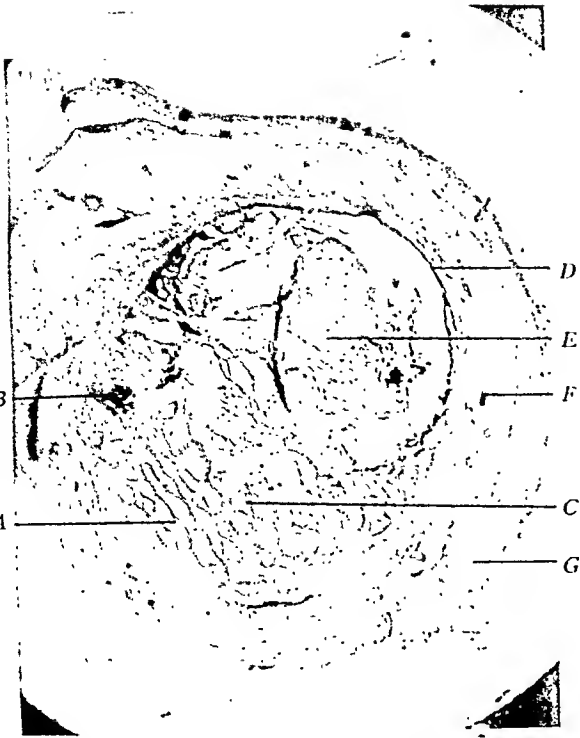


FIG. 29.—Intra-appendicular mucocoele. A, large mucosal glands, in which nearly all the cells are of the mucous or goblet type; B, lymphoid tissue; C, papilla-like projections of the mucosa; D, portion of lumen lined by single layer of epithelium; E, mucus; F, broad submucous connective tissue coat; G, infiltrated and deformed muscular layers.

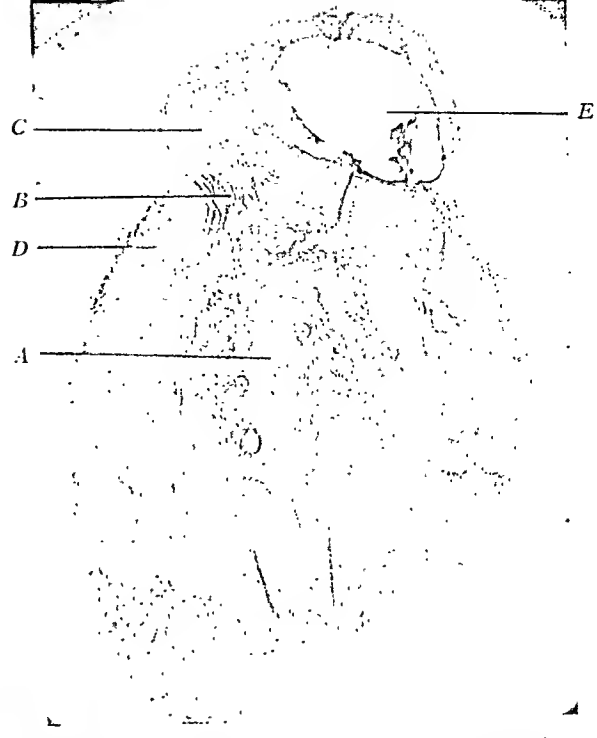


FIG. 30.—Extra-appendicular mucocoele. A, firm connective tissue obliterating lumen; B, hiatus in muscular coats; C, connective tissue plug over hiatus; E, mucocoele

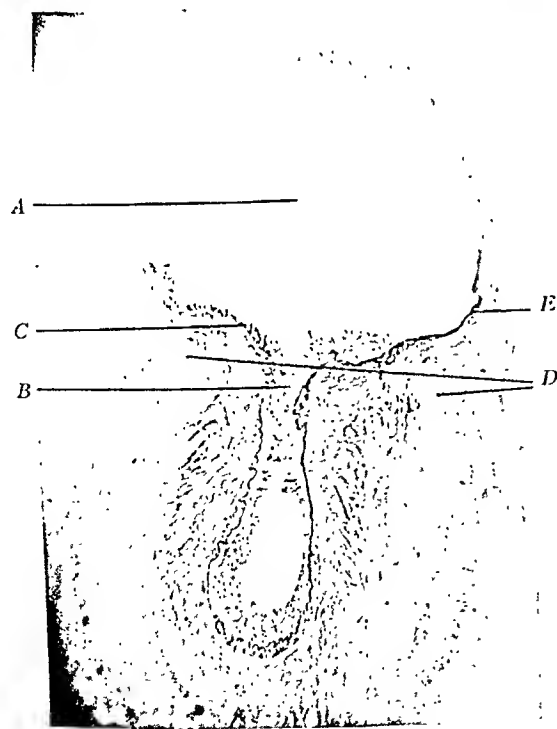


FIG. 31.—Diverticulum of the appendix. A, diverticulum; B, communication between diverticulum and lumen; C, mucosa lining diverticulum; D, end of muscular coats; E, single layer of epithelium lining remainder of diverticulum.

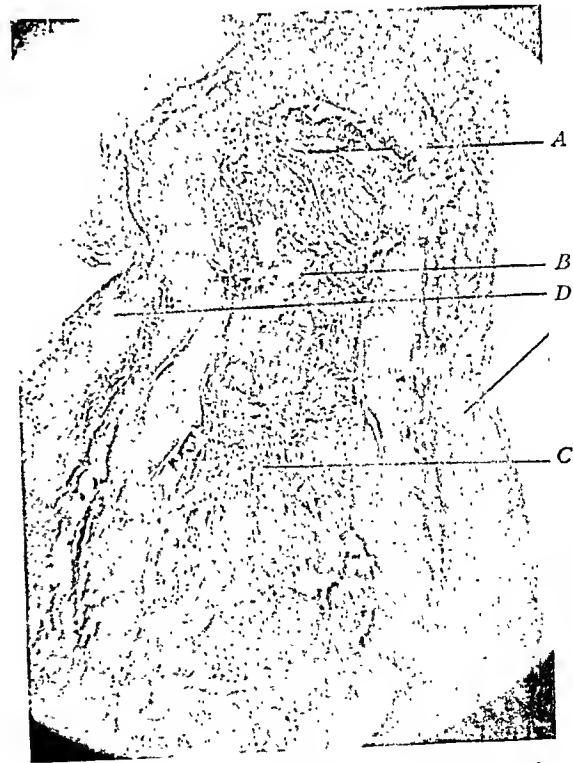


FIG. 32.—Acute appendicitis within a diverticulum of the appendix. A, lumen of diverticulum filled with fresh exudate; B, communication between diverticulum and lumen; C, lumen filled with fresh exudate; D, ends of muscular layers.

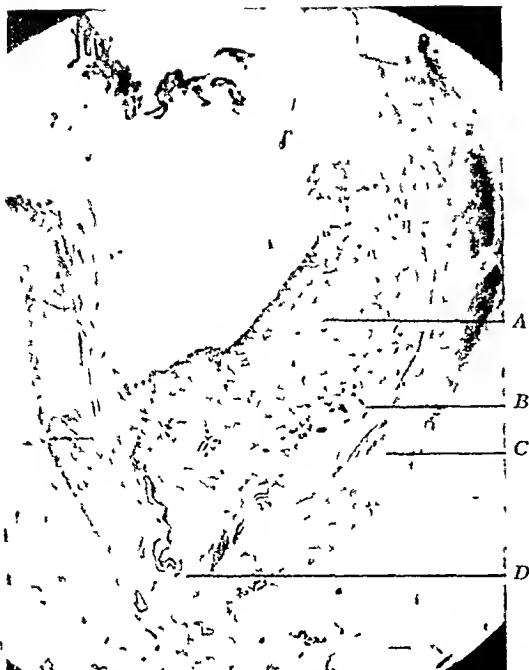


FIG 33 —Scirrhous carcinoma of the appendix. *A*, carcinoma, *B*, submucous connective tissue zone; *C*, normal muscular layers, *D*, entrance of blood-vessel into appendix.



FIG 34 —Medullary carcinoma of the appendix. *A*, carcinoma, *B*, lymphoid tissue



FIG 35 —Carcinoma of appendix with acute appendicitis. *A*, carcinoma



FIG 36 —Adenocarcinoma of the appendix. *A*, adenocarcinomatous mass filling lumen, *B*, intact mucosa

evidenced by the more fibrous organization. The organization of the new connective tissue in the muscular and peritoneal coats is more nearly complete, consisting of firm tissue with few cellular elements.

Fig. 14 (3187). This represents a nearly completely healed appendix. The granulation tissue still contains a considerable number of cellular elements, indicating that complete organization has as yet not taken place. The same is true of the new connective tissue in the muscular and peritoneal coat.

Summary of the Lesions of Healing Appendicitis.—These appendices reveal a progressive healing, in which each stage of the process may be traced from the ravages of the acute attack. The course of events is the following: The exudate or membrane breaks down, becomes necrotic and leaves an ulcer which gives birth to granulation tissue. The extent of this granulation tissue depends upon the extent of the destruction of the mucosa. If the mucosa has been completely destroyed, no regeneration of epithelium is possible and the ensuing organization of the tissue results in complete obliteration. If the mucosa has not been completely destroyed, the epithelial lumen is restored, a stricture is formed, the size of which is obviously in inverse ratio to the extent of the mucosal destruction.

At the same time, the formation of new connective tissue in the muscular coats leads to two changes: (1) Deformity; (2) separation of the fibres by newly-formed connective tissue. In the peritoneal coat the formation of the new connective tissue and destruction of the surface epithelium also lead to two changes: (1) Thickening; (2) formation of adhesions. All these changes I shall demonstrate under the next heading.

Healed or Chronic Appendicitis.—Fig. 15 (2815). The lumen is small. The striking feature is the absence of the large normal crypts of the appendix. The lymphatic tissue of the appendix is sparse, as compared to the normal, while the lymph centres are entirely absent. Proceeding outward we find a very broad submucous connective tissue space, many times wider than the normal. The fibres of the muscular coats run more or less irregularly and here and there are areas of new connective tissue between the bundles. The peritoneal coat is distinctly thickened and densely fibrous.

Fig. 16 (3236). Note again the small circular cryptless lumen, and the broad submucosa which has been so greatly pulled, as it were, from the muscular layer, that a definite space has been formed. The mucosa is held to the muscular layer by few and delicate strands of connective tissue. Otherwise the same changes are present as in the previous specimen. (The blood within the lumen is the result of trauma incident to the operation.)

Fig. 17 (4456). An extremely fine lumen, surrounded by an island of mucosa and a fair amount of lymphoid tissue. Again I call attention to the broad and very attenuated submucosa. The peritoneal and muscular coats show both slight infiltration and deformity.

Obliteration.—Fig. 18 (2862). There is not the slightest trace of epithelial mucosa. The central portion of the appendix is filled by a firm fibrous tissue with many newly-formed blood-vessels. A small amount of lymphoid tissue is present near the centre of this new tissue. Proceeding outward we find a broad honeycombed submucous layer. The muscular coats are infiltrated with firm fibrous tissue; the muscle-bundles show deformity in arrangement. The peritoneal coat shows slight thickening and infiltration.

Fig. 19 (4000). The same changes as the preceding, except that the new fibrous tissue is denser, and the infiltration changes in the muscular coats are more profound. The lymphoid tissue has disappeared and almost completely. This appendix is characterized by a bulbous tip.

Fig. 20 (2820). This appendix reveals the same lesions as the previous two, except that here the broad submucosa shows extreme attenuation, as in Fig. 15.

Summary of Lesions of Chronic Appendicitis.—The histological characters of a healed or chronic appendicitis are therefore the following:

1. A narrow lumen (stricture) or
2. Complete obliteration of the lumen by new connective tissue.
3. The absence of mucosal crypts. This absence indicates, except in cases where the lumen of the appendix has been dilated from other causes (to be shown later), that a previous acute suppurative inflammation has taken place. This phenomenon is important in differential diagnosis, in cases where there is a question as to whether the lumen of the appendix is narrower than normal.
4. The widening of the submucous connective tissue zone.
5. The attenuation and diminution (or even complete disappearance) of the lymphoid tissue.
6. The infiltration of the muscular coats by new connective tissue, and consequent deformity.
7. The thickening, increased density and deformity of the peritoneal coat.

Pathogenesis.—The important point is that all these changes have not originated *de novo*, but are directly consequent on and traceable to the ravages of a previous attack. We have already seen that the primary exudate or membrane arising from the crypts destroys in part or wholly the mucosa of the appendix. We have seen, when the acute process has been arrested, how, as in all other membranous inflammations, the exudate necroses, and is cast off, leaving smaller or larger ulcers, the bases of which consist of newly-formed granulation tissue. We have also seen, in connection with the subacute forms (Fig. 10), how the uninjured epithelium regenerates and covers the adjacent ulcer. When complete healing takes place we therefore necessarily get either a stricture, the size obviously in inverse ratio to the extent of the epithelial

destruction; or, if the destruction of the epithelium is complete, obliteration and filling up of the lumen by the newly-formed scar tissue. The destruction of the epithelium and the consequent contraction of the surrounding scar tissue obviously explain the absence of mucosal crypts.

The attenuation, diminution and occasionally even complete destruction of lymphoid tissue is due to infiltration and destruction by the purulent inflammation, described in the acute variety, and consequent replacement of the destroyed portions by newly-formed connective tissue. As I have already pointed out, the lymphatic apparatus of the appendix possesses a peculiar immunity from the destructive process, and it is unusual not to find some traces in the healed appendix.

The attenuation and increased width of the submucous connective tissue coat is due to contraction in the central area of the appendix, the result of ulceration and subsequent scar tissue formation. The width of the submucosa necessarily depends upon the extent of the central destruction. The infiltration of the muscular coats by new connective tissue and consequent deformity of the arrangement of the muscular fibres is also the direct sequel of the acute attack. The extensive early purulent inflammation disappears and is replaced, as in every purulent inflammation of other muscles, by new granulation tissue, which subsequently organizes, leaving a residuum of fibrous or scar tissue. Such fibrous tissue is found in practically every case of chronic appendicitis, and without even any other evidence is a definite sign of previous inflammation. Sometimes, however, the exudate completely absorbs and leaves so little fibrous tissue in its wake, that the muscular coats again appear practically normal. The thickening, increased density and deformity of the peritoneal coat are explainable in the same way.

Now it is entirely conceivable that if the acute process has been arrested very early, say in the stage exemplified by Fig. 2, the subsequent healing may result in a restitution to normal. I will admit that this is possible. But I have never seen any appendix that showed arrest of the process at this stage. If healing occurs, it is always at a considerably later period than this, when destruction of the mucosa has been vastly more extensive. As a result of my observations, therefore, I should say: First, *an acute appendicitis always gives rise to permanent pathological changes*; and second (a corollary of the previous statement), *a normal appendix never has been the seat of an acute attack*.

Of the diagnostic characters of healed or chronic appendicitis I lay most emphasis upon the first four, namely: (1) stricture, (2) obliteration

tion, (3) disappearance of crypts, (4) widening of submucosa. I emphasize these because they are easily recognized by the naked eye in a cross-section of the organ. Of them all, I lay the greatest stress upon the increased widening of the submucosa, because, while one or the other of the above signs may be absent, this sign is practically constant.

I come now to a rather significant conclusion. It has been noted that in the discussion of these phases of appendicitis I use the word "healed" in addition to the label "chronic" appendicitis. I do so purposely in order to convey the firm impression that the changes I have described are not progressive or continuous, as they are in the majority of chronic inflammations within the body, but are end-products of an acute inflammation; products that forever remain quiescent unless an additional insult arises. A chronic appendicitis arising in another way than that which I have presented, I believe does not occur. I make this statement purposely rather sweeping, because some clinicians speak of a slow, progressive form of appendicitis, expressed conventionally by the term "chronic catarrhal appendicitis" or by "involution of the appendix." I am sure nothing in the appendices I have shown can in any way be covered by the term "catarrhal," a word of wide and various definition; and I am equally convinced that the changes usually associated with so-called "involution" are always the result of a previous attack or attacks, as the study of the histories of these patients has proven.

For these reasons, I hold the term "healed appendicitis" as more appropriate than "chronic appendicitis," because it conveys a closer interpretation of the process. I need hardly say that the term "healed" is used here in the pathological and not in the clinical sense.

DISEASES OF THE APPENDIX SIMULATING APPENDICITIS

Submucous Hemorrhages of the Appendix.—These are noted frequently in excised appendices, and appear as smaller or larger petechial spots scattered throughout the mucosa. In previous years this finding was sometimes viewed as a manifestation of early inflammation, but it is now generally accepted that the hemorrhages are due to operative trauma.

Fig. 21 (3688). The submucous hemorrhages are fairly extensive and involve only the portion of the mucosa between the lymph follicles. The remaining coats of the appendix are normal.

Fig. 22 (3758). The same as the preceding except that some of the hemorrhages have ruptured through the mucosa. In these appendices, the lumen will, obviously, contain fresh blood.

Coproliths.—Fig. 23 (2776). The coprolith is represented by an amorphous mass filling the lumen of the appendix. The lumen is enormously dilated; all the coats in consequence are thin and approximated to one another. The epithelial lining is intact in places; in others it has been rubbed away. The latter finding, I have demonstrated to my satisfaction, is an artefact, due to incision of the appendix through the coprolith. If the coprolith is first gently removed, before incision of the appendix is proceeded with, the epithelial lining will be found intact as the following specimen demonstrates.

Fig. 24 (3803). Dilated appendix due to coprolith.

In both Figs. 22 and 23 there is no evidence whatever of acute or chronic inflammation.

Comment.—I fully agree with Aschoff that coproliths are not a direct cause of acute inflammation. By that I mean, that the coprolith by its irritation does not cause direct injury of the mucosa and consequent invasion by microorganisms. The reason for so believing is that I do not recall ever having seen an acute appendicitis limited to the site of the coprolith. When acute inflammations occur in appendices containing coproliths, the lesion is distal to the coprolith and involves the proximal portions only by extension. On the other hand, this observation lends support to the belief that the coprolith is probably a factor in contributing to an attack of appendicitis only in so far as it interferes with the drainage of the organ. That perforations readily occur at the site of coprolith is easily surmised from the thinness of the coats.

Lymphoid Hyperplasia of the Appendix.—Fig. 25 (3849). The diameter of the appendix is of unusual width. The mucous coat is hypertrophied, due to the enormous increase in the lymphatic tissue. The remaining coats are normal.

Comment.—Such appendices are rare and in my opinion are usually associated with a *status lymphaticus*. I infer this because at post-mortem such an hyperplasia of the lymphoid apparatus is usually found in pronounced cases of this malady. In this instance the appendix was removed from a boy seventeen years of age, who had general glandular enlargement. It is interesting to note that some authors have described these lymphoid hyperplasias as “pseudo-appendicitis lymphatica,” and believe that these appendices cause pain by stretching of the coats. I am unable to vouch for the validity of this contention. The patient from whom this appendix was removed had a duodenal ulcer but there were no symptoms referable to the appendix.

Worms in the Appendix.—Fig. 26 (3121). The lumen contains numerous cross-sections of the oxyuris. These worms consist of an enveloping coat surrounding honeycombed tissue spaces, which enclose the circulatory and digestive tracts. The appendix otherwise is normal. I call special attention to the intactness of the mucosa.

Comment.—If routine examinations of appendices are made, it is surprising how frequently the oxyuris is found, especially in adults. In the past six years, I should say that I have seen this at least two dozen times. As a rule, also, the appendices have been removed in the course of operations for other intra-abdominal conditions. In some instances, the appendix was removed for pain; and in one very recent instance, the diagnosis of probable thread-worms was definitely made by my assistant, Dr. Shapiro. I conclude, therefore, that thread-worms occasionally cause pain, although this is the exception rather than the rule.

I have never seen any penetration of the tissues of the appendix by the oxyuris, although this has been described by some authors, notably by Cecil and Bulkley in this city.

Fig. 27 (3143). Appendix containing trichocephalus dispar. A cross-section of a worm is noted, partly imbedded in the mucosa and surrounded by a very thin prolongation of the adjacent epithelium. The blood in the lumen may be the result of the notorious blood sucking capabilities of this parasite; or, more probably, it is adventitious, due to trauma.

Comment.—This is the only instance of trichocephalus infection of the appendix that has come under my observation. The patient had symptoms which strongly suggested an attack of appendicitis three weeks before.

Decidua of the Appendix.—Fig. 28 (3613). This appendix was removed in the course of an operation for right-sided ectopic gestation of three months' duration. Grossly, the appendix was normal. Microscopic section shows the peritoneal coat irregularly thickened. This thickening is due to the presence of decidual cells of the classical type. The appendix otherwise is perfectly normal.

Comment.—As far as I am aware, this is the third case reported of decidual reaction in the appendix. In all three instances, there was a right-sided ectopic gestation. I have examined a dozen or more appendices removed during the course of operations for ectopic pregnancy, some even intimately adherent to the ectopic mass, but I have never since found the lesion.

This lesion is not as strange as may appear at first sight, when we consider that even in normal intra-uterine pregnancy, there is a widespread decidual reaction in the subperitoneal connective structures within the pelvis. Decidua is found not only in the mucosa of the uterus, but in the form of tubercles on the posterior aspect of the uterus, in the pouch of Douglas, and on the surface of the Fallopian tubes. I have also observed a decidual reaction on the surface of the ovary in a case

of ovarian pregnancy. It has been found even in ovarian cysts and in intestinal adhesions, always associated, of course, with pregnancy. It might, therefore, have been predicted, that sooner or later a decidua reaction would be found in an organ so contiguous to the internal female genital organs as the appendix.

Intra-appendicular Mucocoele.—Fig. 29 (3870). Even at a superficial glance we note an unusual and profound change in the mucosa. Upon one aspect the glands are much dilated, the individual cells are greatly swollen and, what is especially striking, all have been converted into the mucous or goblet type. In the normal appendix, be it remembered, these cells are present, but in the minority. The surface epithelium, moreover, instead of being smooth, is thrown up into large villous folds. The lymphoid stroma is unusually small in amount and thin. Upon the opposite aspect of the lumen, the glands and stroma are entirely absent, so that the lumen is lined by a single layer of low cuboidal epithelium. Another striking feature is the filling up of the lumen by mucus. The epithelium lies directly against the connective tissue of the submucous coat without the interposition of lymphatic tissue. The submucosa is broad; the muscularis shows deformity and connective tissue infiltration.

Comment.—The lesion corresponds in general to that strange pathological entity, mucocoele of the appendix. The only difference is that the reported mucocoeles are much larger, often huge. Most observers agree that mucocoeles, as my specimen indicates, are sequelæ of inflammation. If these mucocoeles rupture, we may obtain that curious phenomenon, "mucoperitoneum," where the peritoneal cavity contains sometimes quarts of mucus. I do not believe that this phenomenon, which has also been described in rupture of the Fallopian tube, has ever been satisfactorily explained.

Extra-appendicular Mucocoele.—Fig. 30 (3504). Upon the peritoneal surface is a small connective tissue vesicle, lined by mucus. There is no epithelial lining. The vesicle has an intimate relation with a prolongation of connective tissue that passes through a definite hiatus in the muscular coats of the appendix; the connective tissue arises from the fibrous core of a completely obliterated appendix.

Comment.—It appears that this mucocoele has a definite relation, pathogenetically, to a previous perforation of the appendix, as evidenced by the hiatus of the muscular coats. Whether the presence of mucus is due to the remnant of a small section of prolapsed mucosa (like an implantation cyst) or to simple degeneration of the newly-formed connective tissue, I am unable to say. The second interpretation is, to my view, the more reasonable one.

Diverticulum of the Appendix.—Fig. 31 (3275). An exquisite example, where the diverticulum is nearly as large as the appendix itself. The diverticulum is formed by a prolongation of the mucosa through a distinct hiatus in the muscular

coat. The diverticulum therefore has nothing but a connective tissue and peritoneal covering. The inner surface is lined for a considerable part of its circumference by epithelium; the remainder contains a fresh exudate. The appendicular walls show evidences of acute inflammation (œdema, infiltration with polymorphonuclear leucocytes).

Fig. 32 (3304). Shows a smaller diverticulum than the preceding. The acute inflammation is more extensive and has resulted in complete destruction of the mucosa.

Comment.—Diverticulum of the appendix has come under my observation four times. In all there was an associated acute inflammation. I shall not enter into a discussion of the pathogenesis of diverticula of the intestine, because I have no definite views upon the subject. It is still a matter of controversy.

Carcinoma of the Appendix.—Fig. 33 (4670). This appendix was taken from a girl, nineteen years of age, who had suffered with pain in the right iliac region for the previous four years. A mass the size of a pea was found filling the tip of the appendix.

The tumor is a typical scirrhous carcinoma. The cells are small and polyhedral; the nuclei are small, regular and not very rich in chromatin. Note that the submucous connective tissue shows not the slightest evidence of invasion; it forms a capsule, as it were, to the tumor. The muscular coats also are normal.

Fig. 34 (3475). This appendix was removed from a man aged fifty-one, who had suffered for some months from indefinite abdominal pains. The tip of the appendix was bulbous. On section the appendix contained a large bean-shaped growth entirely obliterating the lumen.

The tumor is a typical medullary carcinoma. In contradistinction to the usual medullary carcinoma the cells are not very atypical. The nuclei are fairly uniform in size and show very few mitoses. In places we see invasion of the muscular coat by the growth. Here and there we note intact remnants of the lymphoid apparatus.

Fig. 35 (5496). Removed from a girl, fifteen years of age, during her first attack.

This specimen shows the value of routine examination of all specimens. In addition to a typical acute suppurative appendicitis, we find an area of undoubted carcinoma, involving the muscular and peritoneal coats. The structure of the carcinoma is that of the previous specimen (Fig. 34).

Fig. 36 (2582). Removed from a woman, aged thirty-five, eight years ago. The only symptom was tenderness at the site of the appendix, accompanied by alternating constipation and diarrhœa. Thus far the patient remains well.

We note a dilated lumen with intact epithelium. The lumen is filled, however, by a solid growth of typical adenocarcinoma. Inasmuch as the tumor seems to have no definite origin from the mucosa, we presume that it arose from a portion of the appendix just above or below this section. Before we could determine this, the appendix was unfortunately thrown away.

Comment.—These four appendices exemplify the predominant types of carcinoma found in the appendix. Much has been written on the

PATHOLOGY OF APPENDICITIS

subject, so that it will be unnecessary for me to enter into an extensive discussion. I merely desire to call attention to certain curious features of this disease. Carcinoma of the appendix differs from carcinoma of other organs and especially of the intestinal tract, in a number of features: (1) It occurs as a rule in much younger individuals; most commonly in the second and third decades. Two of our cases exemplify this. (2) Carcinomata of the appendix, both pathologically and clinically, are of a very low grade of malignancy. Appendix carcinomata resemble other carcinomata only in their alveolar structure and the epithelial type of cell. In other respects, they differ histologically from other carcinomata. The cells are smaller and less atypical; the nuclei show little variation in size and shape, are less rich in chromatin, and comparatively free from mitotic figures. Finally, there is less tendency to invasion to neighboring organic structures, and practically no tendency to metastasis. Indeed, we find these pathological data brought out by clinical experience. Carcinoma of the appendix has by far the best prognosis of any cancer in the human frame. I believe the reports of fatal cases are rare. Perhaps one of the reasons for the favorable prognosis is the early diagnosis of appendicular pain, due to the prompt interference with the drainage of the narrow lumen of the organ by the growth of the tumor. (3) The vast majority of carcinomata of the appendix is of the solid type, whereas the carcinomata of the intestine are of the glandular type.

These facts have, in times past, made me wonder whether carcinomata of the appendix are *bona fide* cancers. But after considerable study and much reflection I have not been able to arrive at any other conclusion.

CONCLUSIONS

1. The pathological lesion of acute appendicitis represents a suppurative process from the very beginning. The earliest lesion is as pathognomonic as the primary lesion of syphilis, and all the subsequent stages of the disease within the organ are directly traceable to the spread and development of this lesion. There is no pathological evidence that an "acute catarrhal" inflammation of the appendix occurs.

2. The changes associated under the name "chronic" appendicitis (stricture, obliteration, etc.) are pathogenetically the healed products of the acute lesion. According to this interpretation, chronic appendicitis is not a continuous progressive inflammation, but an end-product. There is no pathological evidence of "involution" of the appendix, or of "chronic catarrhal" inflammation of the appendix.

3. The only justifiable classification of inflammation of the appendix, therefore, is the following: (1) Acute appendicitis; (2) healing or subacute appendicitis; (3) healed or chronic appendicitis.

4. An acute localized peritonitis with the formation of fibrin and limited to the site of the lesion is always present in acute appendicitis as early as twelve hours after the onset (and perhaps earlier); so that the absence grossly of a localized peritonitis, in suspected cases, is *eo ipso* evidence of absence of acute appendicitis.

5. In addition to obliteration and stricture, attention is called to two new, easily recognizable, constant and pathognomonic signs of chronic appendicitis, namely: (1) Absence of mucosal crypts; (2) marked widening of the submucous connective tissue zone. The latter sign is especially easy to determine upon cross-section of the organ, and is recommended as the simplest way to determine the presence or absence of a chronic appendicitis.

6. Cross-section of the appendix at various levels is far preferable to longitudinal section, to determine pathological changes.

THE TREATMENT OF THE RETROCÆCAL APPENDIX

By HARRY A. SHAW, M.D.

OF SEATTLE, WASH.

THE difficulties encountered in the removal of a retrocæcal appendix at times transform an otherwise simple operation to one almost formidable. The incidental trauma, possible injury to the great vessels and ureter, hemorrhage and deperitonealization, coupled with the danger of rupture to the appendix or its mesentery, etc. (see Fig. 1), certainly call for operative measures more finished and more surgical *than digging it out in the blind*.

We have at our command a simple, clean, bloodless technic with which we can render the delivery of a retrocæcal appendix a finished anatomico-surgical procedure, *i.e., the mobilization of the cæcum and colon* in the conventional manner (see Figs. 4 and 5) and the freeing and delivery of the appendix under sight.

The following summary¹ shows the chief etiological factors in placing and retaining this type of appendix in its retrocæcal position, to be:

"First, the influence of peritoneal adhesions established during the descent of the cæcum from its subhepatic position to the iliac fossa.

"Second, the inherent curve of the fetal pouch.

"Third, the unequal development of the pouch."

The appendix may be found in any part of the abdomen; this is due to numerous etiological factors, more especially to conditions of arrested development of the colon. However, in this brief paper, I do not wish to confuse the issue by the injection into the subject of any of the multifold varieties of aberrant appendices, except the retrocæcal, and then only to that type of retrocæcal appendix associated with a cæcum whose descent is more or less complete, or at least in a subhepatic position (see Figs. 2 and 3). However, with a careful consideration of the relational anatomy, the suggested technic may be applied in principle to any case.

When retrocæcal, the appendix must of necessity lie to the right (external), or in rare cases, beneath (posteriorly) the mesocolon; this point is one of great importance when we come to consider the blood supply and the factors in delivery which are productive of hemorrhage.

The appendix may be primarily adherent to either the parietal

¹ Huntington: Anatomy of the Peritoneum.

peritoneum or to the posterior visceral peritoneum of the cæcum and colon and, after fusion of the parietal and visceral peritoneum occurs, it becomes hermetically sealed (see Figs. 2 and 3). Where fusion has not taken place (26 per cent. of cases) simple manual rotation of the colon inward will reveal the appendix adherent to the visceral peritoneum of the cæcum and by incising the peritoneum external and lateral to the antimesenteric border of the appendix to avoid severing vessels of the meso-appendix, it will usually free easily from its visceral attachments by dry gauze dissection from without inward.

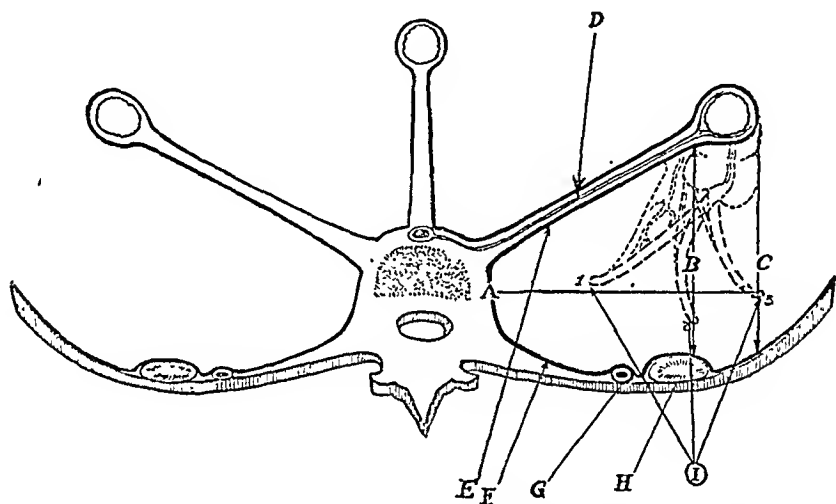


FIG. 1.—This is a schematic representation of the colon and certain structures before fusion. A to C (black line) represents the potential space between the visceral (E) and parietal (F) peritoneum before fusion, the appendix may adhere and become fixed anywhere within this space. B to C represents the retrocolic portion of the above space (i.e., A to C). This is the common site of adhesions between the appendix and either the visceral or parietal peritoneum; therefore, the commonest location of the retrocæcal appendix. D, blood supply of the colon (branches of the mid-right or ilioocolic vessels) after fusion of the post layer of the mesocolon (E) with the parietal peritoneum (F). It can be readily seen how intimate the appendix must become when confined within space (A-B). E, posterior layer of the mesocolon before fusion. F, parietal peritoneum before fusion. G, ureter; always liable to positive injury in certain types of firmly fixed appendix. This could readily occur by blindly digging the appendix out, but with the cæcum mobilized the delivery of appendix by multiple ligation under sight renders such accident almost gross carelessness. H, lower portion of the kidney. I, dotted outlines 1, 2, 3 representing the appendix and its mesentery in various positions and its possible relation and directions in reference to surrounding structures as well as its own blood supply. Note how traction in certain directions must of necessity produce corresponding deformities of the cæcum and alter the direction of its longitudinal bands. By keeping this point in mind and connecting up cause and effect it will assist us materially in locating the appendix.

After removal of the same in the usual manner, colocæcoplexy will perfectly peritonealize (see Fig. 5).

In that type of cases where the colon has not fused, the retrocæcal appendix is rare and, if it occurs, is generally adherent to colon and not the posterior parietes primarily (Fig. 2, C). However, a chronic appendix held in this position usually adheres more or less in time, simulating developmental fusion.

It would seem apropos to the writer to digress sufficiently at this

THE RETROCÆCAL APPENDIX

point to suggest the diagnostic points necessary to determine the position of an aberrant appendix, *i.e.*, (*a*) careful survey of the cæcum (with the embryology thereof in mind), (*b*) noting the relative size and position of the terminal sacculi, (*c*) its topographical peritoneal relations, (*d*) the degree of descent, (*e*) its position relative to fixed landmarks,

FIG. 2.

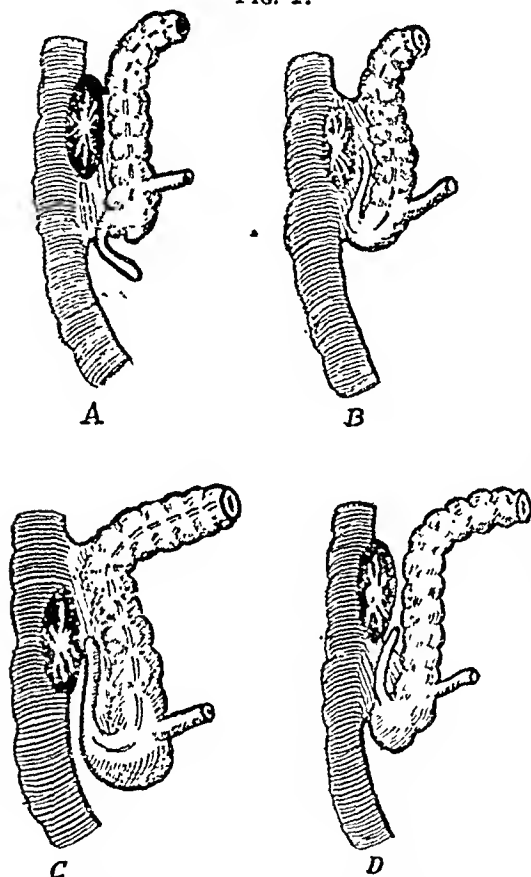


FIG. 3.

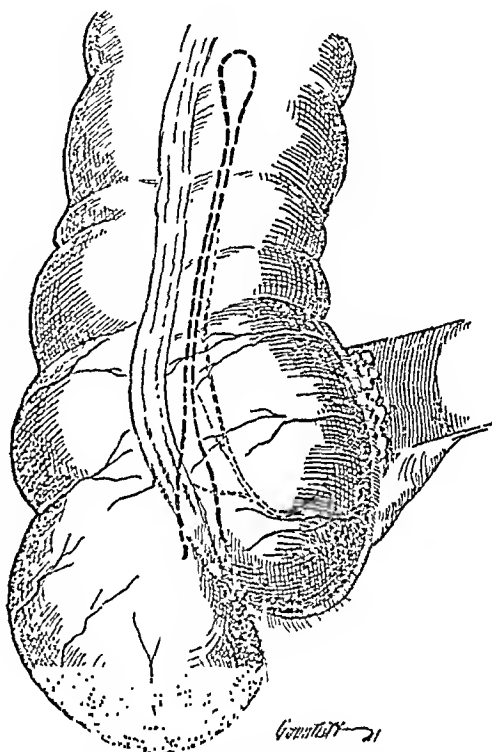


FIG. 2.—Schematic series adapted from Huntington. With the exception of the type illustrated in Fig. 3, these four types, *i.e.*, *A*, *B*, *C*, *D*, represent all of the commoner form of true retrocæcal appendix, with the peritoneal relations thereof. Notice that where fusion has taken place between parietal and visceral peritoneum (*A*, *B*, *D*), the cæcum fails to descend to its normal position. Where fusion fails and the appendix is simply adhered to the posterior visceral peritoneum (*C*) there is usually complete or exaggerated descent. In all of the above types (*A*, *B*, *C*, *D*), there is usually more or less deformity of the terminal sacculi of the cæcum.

FIG. 3.—This illustrates a type of retrocæcal appendix commonly encountered but not mentioned by Huntington. Here the weight of the descending gut evidently produces such strong traction upon the adherent appendix as to cause its marked elongation. This is often incorrectly diagnosed as the obliterative type, believing that its cord-like appearance is due to histo-pathologic changes, not taking into consideration simple elongating due to traction. (The writer has removed one specimen of this type over eleven inches in length. It had a continuous lumen through the full length of which he was able to pass a filiform bougie.) A point to be observed in this variety is the absence of any marked deformity or deviation of the cæcum, which descends practically to the normal level.

(*f*) associated conditions both pathological and developmental, (*g*) the direction of the terminal portion of the longitudinal bands, and (*h*) careful palpation. These are all factors of primary importance in determining the position of the appendix. (Especially practical is the pointer in reference to the direction of the longitudinal bands, see Fig. 1, *I*.)

By keeping in mind the etiological factors in arresting and maintaining *in situ* the retrocæcal appendix, how elementary it would seem to simply reverse the order of their occurrence (*i.e.*, first, adhesion; second, fusion) and, first, mobilize the cæcum and portion of the colon necessary for exposure, then, second, under sight separate adhesions and deliver the appendix.



* FIG. 4.—Cæcum mobilized, exposing retrocæcal appendix in position. This is easily accomplished by first incising the peritoneum partially around the base of and lateral to the cæcum (and colon as far as necessary) and then wiping gut from its areolar bed by simple gauze dissection. The appendix is usually more adherent to the gut than to the parietes and it is usually easier and less traumatizing to rotate the cæcum with appendix intact. However, in exceptional cases where it seems to free easier from its visceral attachments, it is good technic to do so. Whichever plan is attempted, free as much colon as is necessary to ligate meso-appendix under sight, all further exposure is simply a creator of dead space and so much useless trauma. In delivering the appendix, whether attached viscerally or parietally, it is well to simply ligate close to its mesenteric internal border in sections and not attempt to completely free the meso-appendix. (The meso-appendix, like all mesentery, consists of two peritoneal layers which inclose a certain amount of fat and the vascular supply, the peritoneal layers are transformed into simple areolar tissue by fusion, and therefore the only structural integrity remaining consists of vessels.)

The mobilization of the colon is a simple, clean, bloodless and accepted surgical procedure (see Figs. 4 and 5).

The delivery of the retrocæcal appendix in this manner has proven simple and logical in my hands. This method is mentioned by Vosburg² and possibly by others, and I in no sense claim it as original. However,

² Vosburg mentions this procedure in his conclusions on "Non-rotation of the Intestines." Arthur Seymour Vosburg, M.D., ANNALS OF SURGERY, vol. lviii, p. 827.

THE RETROCÆCAL APPENDIX

this much is sure, that the procedure is by no means common, generally understood or adopted,³ and at the expense of reiteration I wish to adduce my personal approval, believing that the delivery of a retrocæcal appendix by mobilization of the cæcum (and colon when necessary) is certainly a distinct step in advance over the dangerous unsurgical technic of *digging them out in the blind* and will certainly bear repetition and re-emphasize a most important procedure.

Believing the subject of developmental anatomy of the gastrointestinal canal and the accepted and conventional facts in regard to

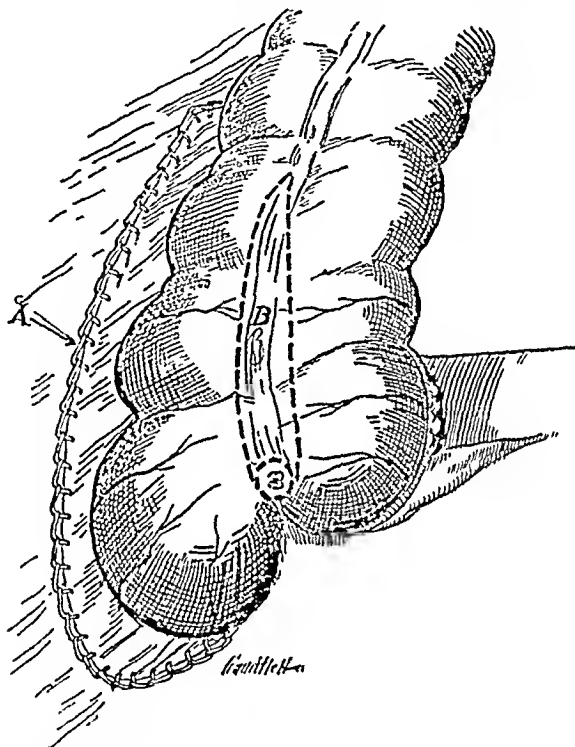


FIG. 5.—Cæcum replaced and fixed by suturing (A), which is carried partially around the base, thus beautifully peritonealizing our raw areas (B).

varieties and etiology of aberrant appendices are not proper subjects for review in current literature, I have endeavored to encroach upon the time of the reader only sufficiently to state certain basic truths, just enough to establish a rationale for the procedure advocated.

³ As a practical example of this I would suggest a glance at vol. lxiv, p. 299, Journal of the A.M.A., to an article by William Neill, Jr., entitled "Exposure of Appendix by Cullen Method." While this appears to me as a decidedly ingenious procedure (I can only speak from the grounds of theory, not practice), I would suggest a comparison of this method with the one advocated by myself, *i.e.*, mobilization, etc. The reader to judge of the relative merits. I mention this article to better emphasize the fact that this procedure (mobilization, etc.) is not in any sense common and is little understood.

HIGH INTESTINAL STASIS*

BY J. E. SWEET, M.D., MAX M. PEET, M.D.

AND

B. M. HENDRIX, PH.D.

OF PHILADELPHIA, PA.

(From the Department of Surgical Research and the Department of Physiological Chemistry, University of Pennsylvania)

THE problem of the cause of death in either the mechanical or functional, *i.e.*, paralytic, obstructions of the upper bowel is not a new problem of surgery. Many explanations have been offered, practically each worker offering a new theory to account for the clinical fact that such disturbances of the normal physiology of the upper bowel are marked by the clinical picture of a grave constitutional disturbance of a manifest toxic nature. Among these theories, for example, were, that the picture is due to central nervous disturbance, to peripheral nervous disturbance, *i.e.*, splanchnic paralysis,—to bacterial invasion, to a loss of a necessary function of the parts involved, to the formation of peculiar poisons, to dehydration by vomiting and diarrhœa, etc.

Instead of following the usual plan of presenting an historical summary of the subject, discussing the various theories proposed, we have thought to present a series of charts, illustrating the surgical conditions involved, in the course of the explanation of which the viewpoints of various workers will be presented.

The problem was made more concrete by the work of Draper. Draper was experimenting with a twine triangular stitch which was to take the place of the elastic ligature devised by McGraw for performing a gastro-enterostomy and was confronted with the difficulty that all his animals operated as in Fig. 1 died before 72 hours, the time which he found to be necessary for the twine stitch to cut a stoma between stomach and bowel. On the other hand, animals operated as in Fig. 2 lived, and animals operated as in Fig. 3 lived as well. In other words, animals in which a blind end of the duodenum longer than 35 cm. from the pylorus was made, lived, while if the blind end was less than 35 cm. in length measured from the pylorus, the animals died. In the first 35 cm. of the duodenum some changes therefore take place under the conditions of obstruction which cause the death of the animal. Draper's further attempts at solving the problem were directed along the line of

* Read before the Philadelphia Academy of Surgery, February 7, 1916.

HIGH INTESTINAL STASIS

his idea that the toxin is a normal product of the duodenum, which, under normal conditions, is neutralized or detoxified by the jejunum.

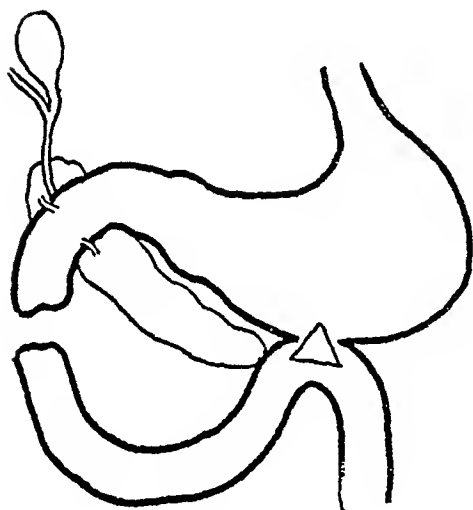


FIG. 1.

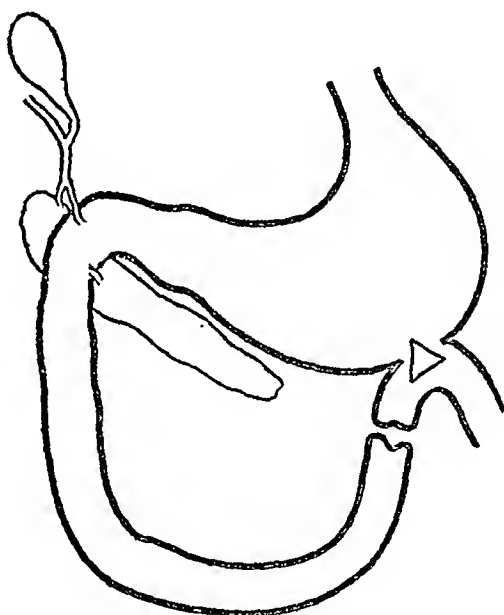


FIG. 2.

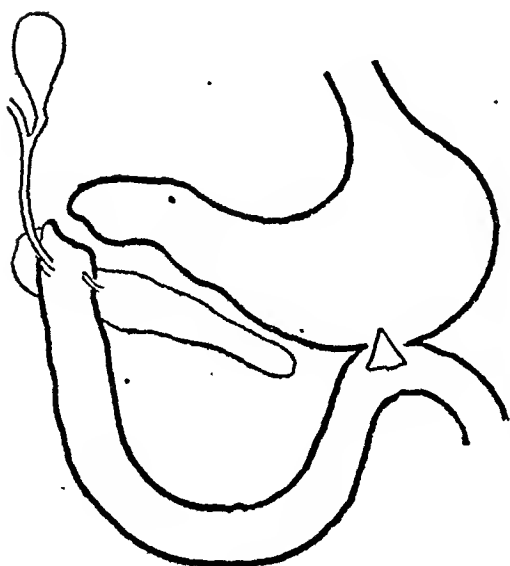


FIG. 3.

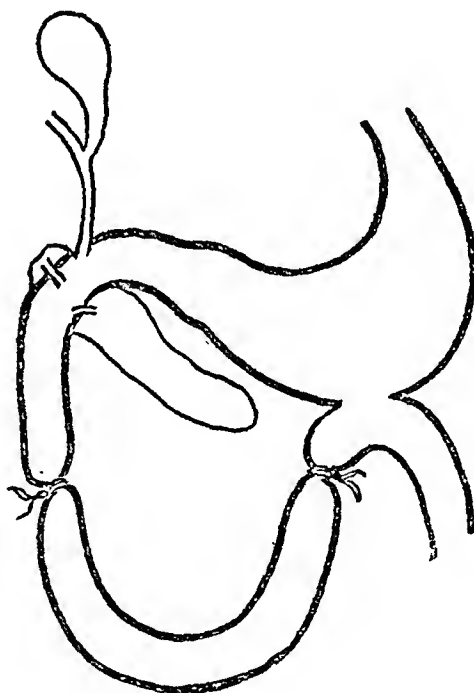


FIG. 4.

As we shall see, his idea may not be so far from the truth although his attempts to prove his point have not been convincing.

Whipple, Stone and Bernheim, of Baltimore, approached the subject by a slight modification of Draper's method, as shown in Fig. 4. To an

ordinary gastro-enterostomy is added a double ligation of the gut at the points shown. On the death of the animal this isolated loop is found to contain a powerful poison, which, free from bacteria, on injection into a normal animal will cause its death with the typical symptoms of high obstruction. This finding would seem to rule out all the other theories which do not include the action of a definite poison.

About this time we became interested in the problem, because of the possible relation to the cause of death in acute pancreatitis. It is, we believe, a generally admitted clinical fact that the symptoms of acute pancreatitis and of acute high obstruction are so alike, if not identical, that a differential diagnosis can only be made at operation. Draper had already expressed himself to the effect that the pancreatic juice, grossly at least, appears to be the lethal agent, and pointed out the technical difficulties in the way of the definite solution of this point. Certain other points needed to be cleared up, because of their bearing on general surgery, and we decided to enter the field.

The first point which interested us concerns the question, of general surgical interest, does a gastro-enterostomy opening really function in the presence of a normal pylorus? In spite of the work of Cannon and Murphy, who by their X-ray studies concluded that such an opening does not function in the presence of a normal pylorus; in spite of the work of Draper, who reported the experiment shown in Fig. 5, in which a string attached to a bolus of food shows at autopsy that it has followed the normal course of the food, there was two or three years ago but a small number of surgeons who believed that the food followed its normal course. Whipple, Stone and Bernheim seemed to take for granted that the gastro-enterostomy opening drains the stomach and upper gut, above their first ligature. It was, however, in our opinion a question whether they were not really studying a condition of functional obstruction of the upper duodenum as well as an actually obstructed portion. If such were the case, their finding of a toxin within this loop would not necessarily mean that it had been formed there; it might just as well have been formed in the functionally obstructed portion and excreted into their closed loop. The fact that they found no toxin in a closed loop the mucosa of which had been destroyed by sodium fluoride would not add further proof, for the destruction of the mucosa would destroy both possibility of formation in the loop and the possibility of excretion into the loop. We therefore tried the experiment shown in Fig. 6. If this operation be done on a series of animals, doing either the end-to-side pictured, or the ordinary lateral gastro-enterostomy, it will be found that some of the animals will die with all the symptoms of

HIGH INTESTINAL STASIS

high obstruction ; and in those that live, either an enormous dilatation of the duodenum, as shown in Fig. 7, will be found at autopsy, or perhaps less dilatation but striking hypertrophy of the muscular layers of this segment of the duodenum.

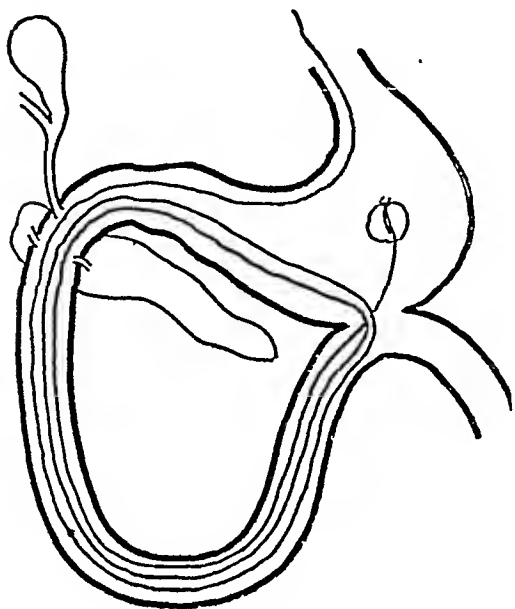


FIG. 5.

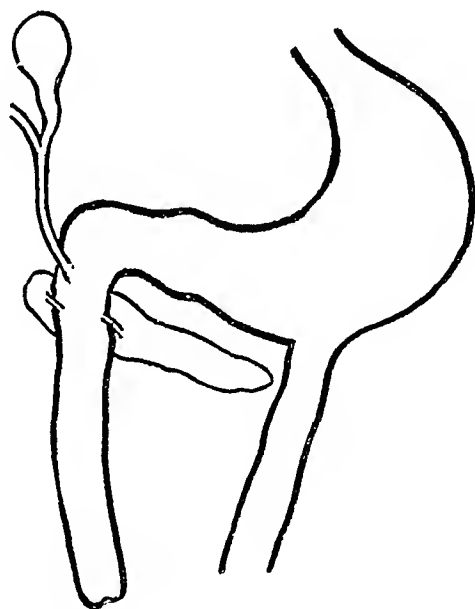


FIG. 6.

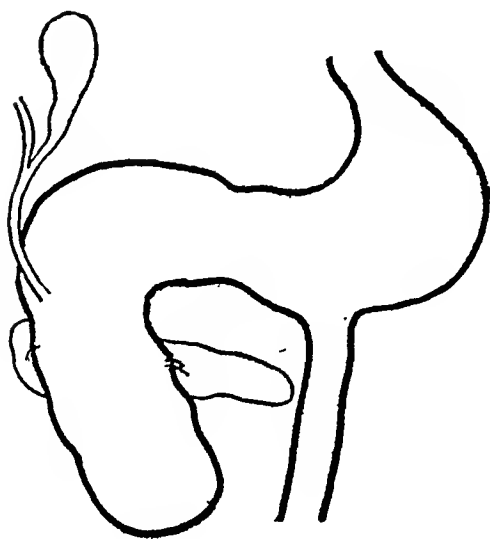


FIG. 7.

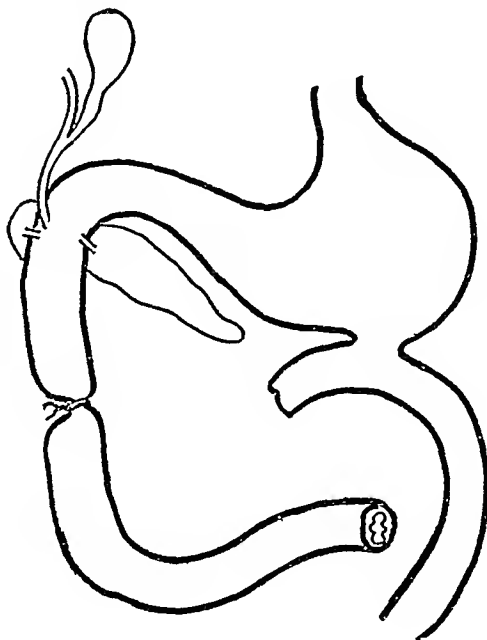


FIG. 8.

It is only this functional obstruction of this first segment of the gut, in Whipple, Stone and Bernheim's experiments, it seemed to us, which could explain the finding which they report after the operation shown in Fig. 8. They report that death follows, even though the isolated loop

be drained to the exterior, and even though it be washed out freely.

We then followed the technic shown in Fig. 9, by which, instead of doing the gastro-enterostomy with its functional obstruction, we isolate the same area of the duodenum as did they, but restore the continuity of the tract by an end-to-end suture, and we found that we could drain the loop at either end, and the animal remained perfectly well. We have had several instances in which the animal has lived for weeks with this loop closed at both ends; we have had many instances in which the animal lived for a week or ten days; we have drained into the bowel below by doing an end-to-side to a point of the bowel lower down, and

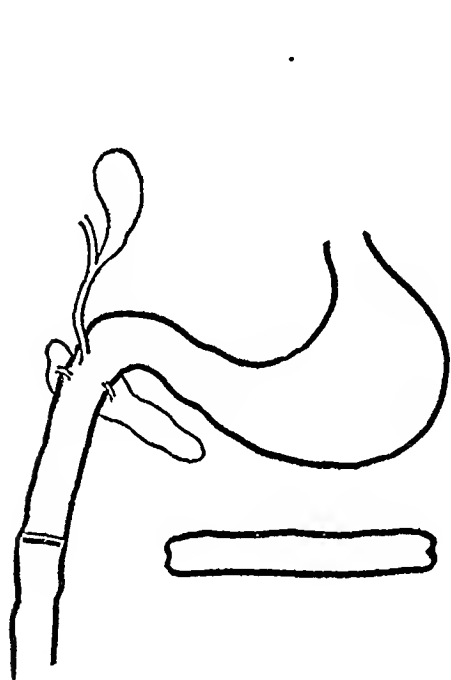


FIG. 9.

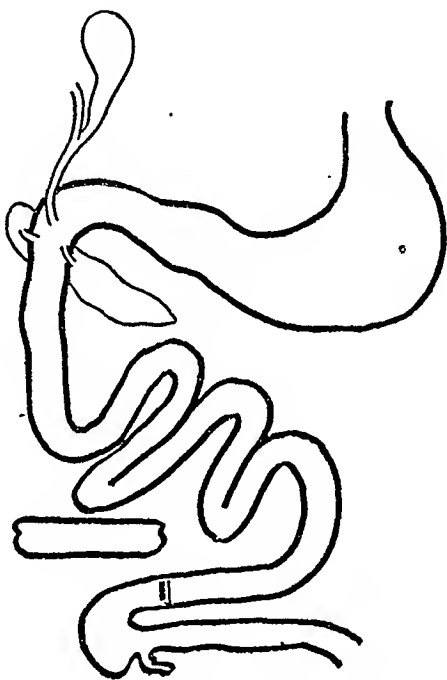


FIG. 10.

nothing happens. We find that such loops, entirely closed, tend to become enormously distended with fluid, and our present opinion is that it is only because of such distention and consequent rupture that our animals with closed loops die.

Now if a loop of the lower ileum be closed off, the continuity of the tract being restored by an end-to-end around the loop, it will be found that the animal will survive for long periods. This was shown by Halsted years ago. We have found that if we make such a low loop, and fill it with pancreatic juice, or with a fresh dog's pancreas, the animal may die in the time limit, and with the symptoms, characteristic of high obstruction. But this experiment is not conclusive of the rôle

of the pancreas or its ferments in the production of the poison in question, for we may have added only the necessary pabulum for the intestinal bacteria. Let us look for a moment at the chart Fig. 12, which shows the toxic products of proteid digestion. Highly toxic properties have been found in the proteose stage of protein digestion. The normal ferments of the stomach and the normal ferments of the pancreas can, of course, break a protein down to this stage; normally it is supposed that the gastric digestion carries the proteins of the food to the peptone stage, from which the digestion is carried to the amino-acid stage by the ferments of the pancreas and the intestine. The intestinal juice is not supposed to contain any proteolytic ferment except the ferment erepsin, which can digest the protein casein, but no others, while its chief function is to digest the proteoses to the amino-acids. But either gastric or pancreatic ferment is capable of producing a toxic proteose. In addition, many bacteria can digest the protein building-stones to the highly toxic amine compounds. Further, the substance lecithin can, by the action of the fat-splitting ferment lipase, be broken down with the formation of the choline bases, some of which, such as choline and neurine, are highly toxic.

Whipple and his associates have recently published their work, which proves that the toxic body found in their high loops is a proteose, and they have further shown that this purified proteose will exactly reproduce the symptoms of high obstruction when injected into a normal animal. This is a very different demonstration from the work of Murphy, of St. Louis, who found that the material from a loop of intestine which had been permitted to "autolyze," *sic* putrefy, in the incubator for some weeks, or that the material from an infected gall-bladder, is toxic. Only the isolation of the poison and the proof that it reproduces the symptoms of the condition we are studying will prove anything.

Now Whipple's demonstration that the toxin involved is a proteose makes it still more difficult to understand his previous contentions that this toxin is formed in the intestinal loop, or by the mucosa of the intestinal loop. For the formation of a proteose a proteolytic ferment is essential, and the mucosa is not supposed to contain any proteolytic ferment except the ferment erepsin, which is supposed to break down, not form, the proteoses. We have found this proteose in our own loops in animals operated as in Fig. 9, and, nevertheless, we are not prepared to admit that this toxin can be formed without the assistance of the pancreatic juice.

We are inclined to rule out the gastric digestion because of the experiment shown in Fig. 11. In an animal in which, a long time pre-

vious, the ducts of the pancreas have been tied, so that for a long period no pancreatic ferments have been entering the intestine, an absolute high obstruction, without the formation of any loops, was produced. Three such animals have lived for seven and eight days, instead of the two to three days a normal animal will live with such an obstruction. Further, we have obtained a toxic material from loops of intestine in such animals which had no external secretion of their pancreas, but it was not a proteose. From the symptoms produced it would seem that this poison belonged in the class of the choline bases. The intestinal juice, while it contains no proteolytic ferment capable of producing a

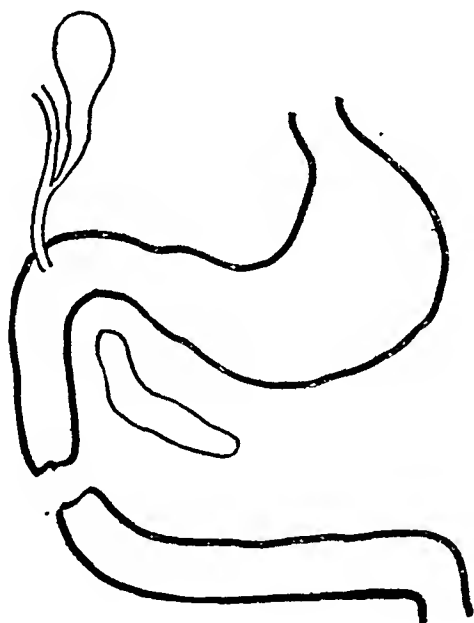


FIG. II.

proteose, does contain a lipase. An animal in which the operation shown in Fig. II has been done should have the products of gastric digestion, which products might contain a proteose, but the fact that they do not die with the symptoms of high obstruction leads us to rule out the stomach.

Two findings in the course of this work have, therefore, interested us surgically. First, the added demonstration of the fact that a gastro-enterostomy opening does not function in the presence of a normal pylorus. The second, the explanation of the similarity between acute pancreatitis and acute high obstruction,—they are alike because they are both essentially the same thing, an intoxication with the toxic products of protein cleavage, in pancreatitis certainly due to the proteolytic

HIGH INTESTINAL STASIS

ferment of the pancreas, in high obstruction not necessarily, perhaps, but in our opinion in all probability, the same toxin, produced by the same ferment. In pancreatitis the escape of the products of the digestion of the pancreas into the tissues permits the intoxication; in obstruction the conditions of obstruction permit the absorption of toxic products, which under normal conditions would either not be formed, or if formed would be immediately broken down to non-toxic products.

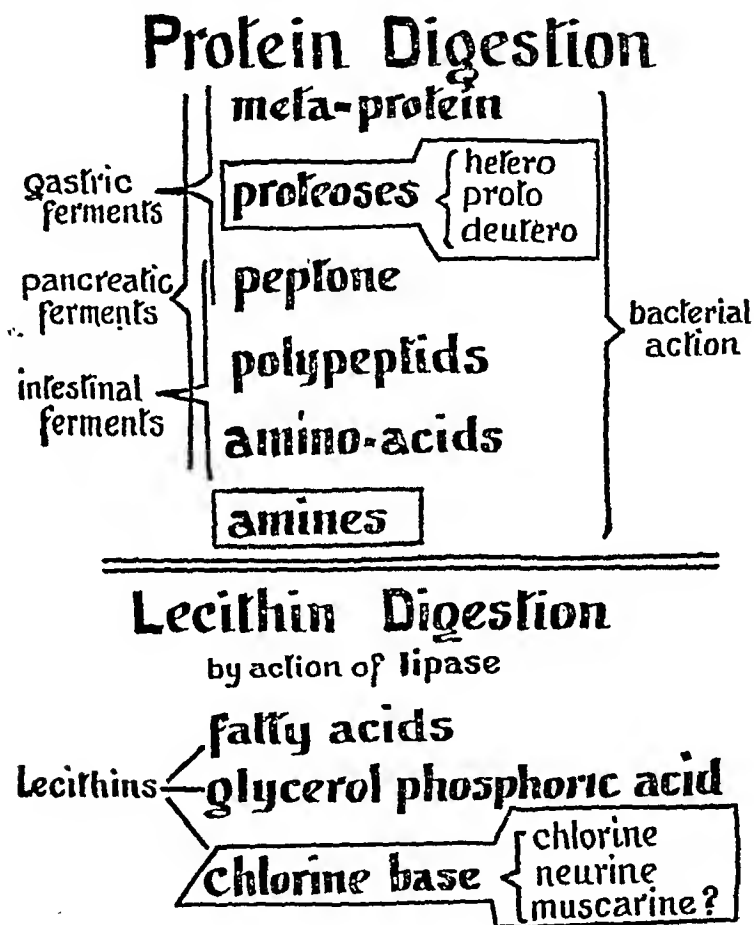


FIG. 12.

Draper's idea that we are dealing with a normal product of the duodenum which in normal conditions is detoxified by the jejunum may be not so far wrong after all.

There is another phase of this problem which we think may have surgical interest and importance. The work which has been done on stasis in the large intestine has all suffered from the fact that no one has ever been able to actually demonstrate any definite poison. Drs. Frazier and Peet have just recounted their failure to find any such toxin; Strauss has recently reported experiments in which he demonstrated

that segments of the colon can be indefinitely isolated. The old experiments of Halsted show that chronic ileal stasis can be indefinitely borne. Are we, perhaps, looking at the wrong end of the intestinal tract, even in these cases? The ptosis of the colon will certainly drag the head of the pancreas across the transverse duodenum, and, indeed, a dilated duodenum has often been reported in these cases. The removal of the colon would relieve this drag. In other words, given the demonstration of a toxin of great potentiality—less than one-tenth of a gramme of this proteose will kill a 15-pound dog in a few hours—would it not be well for the clinician to consider the possibilities of a chronic absorption of such a poison?

We are aware that surgery already possesses a plethora of theories; but as long as a theory is given its proper evaluation as a theory, as a working hypothesis, and is not accepted until supported by such an array of facts that the theory has itself become a fact, these theories offer the only means of progress in a field where so little is known.

EXPERIMENTAL COLONIC STASIS

BY CHARLES H. FRAZIER, M.D.

AND

MAX MINOR PEET, M.D.

OF PHILADELPHIA

(From the Department of Surgery and the John Herr Musser Department of Research Medicine of the University of Pennsylvania)

It is a well recognized fact that more putrefaction takes place in the colon than in any other part of the gastro-enteric system, largely due to the normal stasis in this organ, but since so much attention has recently been directed to the possible absorption of large quantities of putrefactive toxins from abnormal stasis, it was considered advisable to produce experimentally such a condition and to determine by accurate chemical analyses the toxic substances eliminated by the urine.

Since the dog possesses practically a straight colon, it was evident that the maximum amount of stasis without partial obstruction could be secured by a simple reversal of the large intestine, which for some time at least should give a reversed peristalsis, *i.e.*, away from the anus instead of towards it.

The possible action of the liver in removing, before they could be excreted by the kidneys, appreciable quantities of the absorbed products of intestinal putrefaction was determined by the production of an Eck fistula with ligation of the portal vein above the venous anastomosis.

Technic of Colonic Reversal.—Medium-sized female dogs were used. Under ether anæsthesia, a low midline incision was made. A section of colon above the sigmoid varying in length from four to six inches was selected, divided at either end between clamps, reversed, and end-to-end anastomosis performed, silk or chromic catgut being used for the interrupted approximating sutures and silk for the continuous Cushing right-angled suture. The abdominal wound was closed with silk. Recovery was rapid and the post-operative history was satisfactory.

In a few dogs some dilatation of the reversed colon was found at autopsy. This was invariably due to partial obstruction from stenosis at the lower anastomosis. In no case did this added stasis make an appreciable difference in the results.

Technic of Eck Fistula.—Under ether anæsthesia, a midline incision, extending from a little below the ensiform cartilage to the umbilicus, was made. In the first two operations, we followed the technic of

Carrel and Guthrie, the vena cava and portal vein being isolated and their lumen closed by taps or serrefines. Later, a special spring-jawed forceps with curved blades, resembling a diminutive intestinal clamp, was used. We found this greatly facilitated the operation since it entirely did away with the isolation of the vessels. The clamp was placed lengthwise on the vessel and afforded ample room for the anastomosis. The suture technic of Carrel and Guthrie was adhered to with the exception of the needles used. We found by shortening and curving the Kirby No. 16 needles that the stitches could be more easily placed. Paraffin oil was used to prevent clotting. At the completion of the venous anastomosis, a heavy silk ligature was tied around the portal vein close to its entrance into the liver, thus forcing all of the portal circulation directly into the vena cava. The recovery was usually rapid and uneventful.

Results of Reversal of the Colon.—In some dogs, immediately following operation the stools were very soft, but as a rule they were well formed and did not differ in gross appearance from those passed before operation. Practically all the dogs gained weight after a few weeks, although a loss in weight generally occurred at first. One dog weighed nearly twice as much thirteen months after colonic reversal as at time of operation.

Urinary Findings After Reversal of the Colon.—The report of the chemical investigation made by Dr. A. E. Taylor is as follows: Chemical analyses of the urine showed an excess of the urinary bases. These excesses were only marked for a short time following the operation. Later there was little evidence of any excess.

The following substances were demonstrated by qualitative tests: Methylamine, trimethylamine, tetramethylendiamine, pentamethylendiamine, paroxyphenylethylamine. From the presence of the last, we may reasonably infer the presence of phenylethylamine. Methylguanidine, diamethylguanidine, and imidazoylethylamine were searched for in vain.

The finding of these substances can be reasonably interpreted as the result of simple but excessive putrefaction of protein and amino-acids in the colon. Apparently the direction of these processes of putrefaction was not abnormal in the qualitative sense, but only in the quantitative.

The urine of these dogs as well as the substances obtained after chemical isolation of the mixed bases was injected intravenously, but no noticeable toxicity could be established nor did the curve of blood-pressure differ from that to be noted following the injection of normal canine urine.

EXPERIMENTAL COLONIC STASIS

Results Following Reversal of the Colon in Dogs with an Eck Fistula.—The dogs with Eck fistula differed in no way from those with simple reversal of the colon. The stools were well formed, the animals ate well, and no toxic symptoms were demonstrable. The chemical analysis of the urine was the same as before, both qualitatively and quantitatively, showing that the liver had not removed or changed the substance absorbed from the colon.

Conclusion.—The results of these experiments would seem to indicate that mere stagnation of fæces in the colon of the dog, when on a normal mixed diet, does not lead to the formation of toxic substances of note, at least in the presence of the normal flora of the canine colon.

The fact that these dogs remained in perfect health and gained in weight would indicate that simple colonic stasis in the dog is harmless and certainly would suggest that the dire effects attributed to colonic stasis in man were, in part at least, due to some other cause than the absorption of the products usually formed in simple fecal stagnation.

JEJUNAL ULCER, FOLLOWING GASTRO-ENTEROSTOMY FOR DUODENAL ULCER, WITH COMPLETE CLOSURE OF THE GASTRIC END OF THE STOMA*

BY NATHANIEL GINSBURG, M.D.
OF PHILADELPHIA, PA.

THE subject of this communication is the history of a case of jejunal ulcer occurring in an adult male, two and a half years after the performance of a posterior gastrojejunostomy for a duodenal ulcer, correctly diagnosed, and properly treated. The occurrence of a jejunal ulcer in this case following gastro-enterostomy is not regarded as particularly unique in any sense, but the absolute closure of the stoma discovered by radiologic examination, and later confirmed by operative exploration, coexistent with a large jejunal ulcer at the duodenojejunal angle, is deemed a surgical post-operative state worthy of report and record.

While gastrojejunal and jejunal ulcer as a sequence of gastrojejunostomy have been observed in considerably over a hundred cases, the complete closure of the orifice in the presence of ulcer, as far as the search of the literature reveals, was present in only two other instances. The report of this case, therefore, makes three occurrences of gastrojejunal or jejunal ulcer accompanying absolute closure of the stoma created by the first operation.¹

The patient is fifty-one years of age, and has been a cabinet-maker by trade. His occupation has exposed his epigastric triangle to constant traumatism from the pressure of tools in this region. In May, 1912, he was submitted to an operation for duodenal ulcer by another surgeon, a posterior gastrojejunostomy having been performed. His symptoms before this operation were indigestion, post-ingestion vomiting of food, epigastric pain, and loss of weight. The pain occurred one to three hours after taking food. His vomitus did not contain blood at any time, nor was blood ever noted in his stools.

The patient consulted me at the suggestion of Dr. L. H. Jacob, on October 16, 1915, complaining of pain and soreness in the upper abdomen, loss of appetite, vomiting, and gradual and persistent decrease in weight. He was markedly constipated, requiring salts for relief. His pain was relieved by food ingestion, but returned

* Read before the Philadelphia Academy of Surgery, February 7, 1916.

¹ Hartman reports 7 cases of obliteration of the gastro-enterostomy stoma due to cicatrization of secondary gastrojejunal ulcer (ANN OF SURG., June, 1914).

JEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY

some hours later. There was no nocturnal pain or hunger during the week previous to the date I first observed him. He had had eructations of food and gas, lately with daily vomiting after his evening meal. He regarded his condition as rapidly progressive, having lost thirty pounds.

The physical examination of the patient was negative, except for the right rectus scar of the previous operation and marked epigastric rigidity, with tenderness on deep pressure. Radiographic examination of the stomach revealed no indication of the gastrojejunal orifice, and no evidence of pyloric or duodenal blockade. The gastric outline did not suggest gross morphologic disturbance in this organ, and a test-meal did not support retention, since recovery of any portion of the ingesta was not obtained six hours later.

On October 21, 1915, exploration of the upper abdomen through a right rectus incision revealed extensive perigastric and pericolic adhesions to the liver, gall-bladder, and parietal peritoneum. The gall-bladder was easily compressed, and free of stones or gross mural change. Inspection of the duodenum revealed a small stellate scar on the ventrolateral surface of bowel, two inches from the pylorus, the remains of a healed ulcer. There was very slight induration at this point, and no duodenal closure existed, nor was there evidence pointing to previous surgical interference with the bowel lumen proximal to the ulcer. The stomach was mobilized, and inspection of the gastrojejunal site revealed the presence of an annular, circumscribed area about the size of a half-dollar, corresponding to the location of the previously existing communication between the small bowel and the stomach. Invagination was impossible, and apparently no opening existed between the stomach and the intestine. The root of the mesentery contained several large lymph-nodes adjacent to the indurated area.

Separation of the two structures at the gastrojejunal site brought to view a large indurated, excavated ulcer in the jejunum, at the duodenojejunal angle, the base of the ulcer being formed by the gastric wall, and occupying a superior position in the small intestine. The lesion corresponded to the site of the anastomosis. No shreds of suture material were found hanging from the margin, or were discovered embedded in the ulcer tissue. Excision of the ulcer was performed, and the large opening in the jejunum was closed by reversing the axis of the opening by transverse suture of the bowel wound with chromic catgut. Closure of the small intestine was exceedingly difficult, owing to the immobility of the terminal limb of the duodenum lying on the ventral surface of the vertebral column. Interrupted catgut sutures were employed, suspending the intestine from the inferior border of the pancreas

to reinforce those first introduced. The lumen of the bowel after closure was not encroached upon sufficiently to jeopardize its patency at this point. Digital exploration through the opening in the posterior wall of the stomach failed to find any communication between this organ and the bowel. The gastric opening was closed by inversion with catgut, reinforced by seromuscular sutures of silk.

The patient made a rapid and satisfactory recovery from the operation, requiring repeated lavage only during the first twenty-four hours. He has lived upon a carefully restricted diet until within the past few weeks. At present he is well and suffering no gastric disturbance.

Jejunal ulcer and gastrojejunal ulcer as a sequence of gastro-enterostomy have been noted with increasing frequency during the past five years, and the number of recorded cases supported by operative discovery is reaching a considerable size. Schostak, von Eiselsberg, Roojen, Moynihan, Mayo, Patterson, Lieblein and others have called attention to this subject in written communications, and have operated for the removal of this offending feature in the physiologic success of the previously performed gastro-intestinal anastomosis. American medical literature contains but few references to this condition, and those which have appeared are but brief case reports; largely emanating from a single surgical clinic in this country (see Mayo Clinic Reports). Patterson, of London, has contributed the most exhaustive review of the subject of gastrojejunal and jejunal ulcer to be found in the English language. His paper was preceded by a notable study of the subject by Schostak, who with Lieblein has offered the best reports from the continental surgical clinics. Lieblein's paper is a carefully written and exhaustive compilation of all the cases thus far reported in the literature, and pays much attention to the factors relating to the etiologic causes and prevention of this unfortunate operative sequence.

Wolfler first called attention to this condition in 1881; but it was not until 1899 that Braun reported the first case of ulcer of this type before the German Surgical Congress, after having verified at autopsy a perforated jejunal ulcer which followed posterior gastro-enterostomy performed eleven months previously. In 1902, Quènu reported the first case in England. In 1907, Hamann published in the *Cleveland Medical Journal* the first case of perforated jejunal ulcer recorded in America. In 1907, Schostak exhaustively considered 35 cases of ulcer of this type. In 1909, Herbert Patterson, of London, collected 52 cases, and, in 1910, Roojen reviewed 78 cases. Lieblein has collected 129 cases up to the date of his publication (June, 1915), 79 being jejunal ulcers and 50 gastro-

jejunal in type. All these cases were verified by operation or autopsy.

The ulcers, either gastrojejunal or jejunal in type, have been single as a rule, although one case of multiple ulcers of the jejunum occurred in the practice of Lennander following gastro-enterostomy performed for carcinoma of the stomach. At autopsy, the patient having died on the tenth day from peritonitis, the presence of these ulcers was confirmed.

This lesion is distinctly a sequence of gastrojejunostomy performed for the relief of a gastric or duodenal ulcer, and has been reported more frequently in cases following an anterior gastro-enterostomy than after the operation by the posterior route. Fifty-two carefully studied cases were associated with anterior gastro-enterostomy and 25 cases followed the posterior operation.

The frequency with which this type of ulcer has been known to follow gastro-enterostomy for the relief of gastric or duodenal ulcer is difficult of correct estimation. Patterson regarded the occurrence as being 2 per cent., but this percentage is largely conjectural and open to serious question, owing to the fact that his statistics are entirely based upon reports collected from European sources. He excluded in his estimation a great number of operations performed in this country, following which ulcer of this type has not been reported. Since many thousands of patients have been operated upon for gastric and duodenal ulcer in America with relatively few cases of gastrojejunal or jejunal ulcer complicating the post-operative state, it is obvious that no correct estimation of the frequency of this type of ulcer is possible at the present time. This is explained by the fact that highly developed and skilful gastro-intestinal surgery in this country has eliminated the possibility of the frequent occurrence of this complication.

Etiology.—The etiological factors underlying the development of gastrojejunal and jejunal ulcer are numerous and no single element should be regarded as being the causative agent.

So far as the writer has been able to discover, there is no detailed report with relation to post-operative gastric analyses in cases in which gastrojejunostomy had been done for gastric or duodenal ulcer. No doubt much interest would attach to careful systematic studies of a series of cases operated upon, in which ulcer was found at operation. Relief of symptoms occurring in about 85 per cent. of cases following gastrojejunostomy is in itself evidence of the curative value of the operation. However, the 15 per cent. of cases somewhat bettered or not helped by the operation would make an exceedingly interesting subject for future contemplation. Patterson is one of the few who

appears to have systematically studied gastric contents before and after operation, and he has shown that hyperacidity following gastrojejunostomy may occur.

Early closure of the gastrojejunal stoma due to cicatrization, with or without the presence of gastrojejunal ulcer, may occur if the pylorus is patent, and no doubt in these cases future studies will reveal marked hyperacidity of the gastric contents.

W. J. Mayo agrees with Patterson that gastrojejunal ulcers are the result of technical failures in the performance of the operation (gastrojejunostomy), and differ from true jejunal ulcers, which he regards as the result of alterations in the normal physiologic intestinal conditions. In the latter case, the jejunum, which has been constantly bathed in the alkaline pancreatic and biliary secretions, is suddenly subjected to a hyperacid gastric secretion, and therefore loses the surface protection which is present before gastro-enterostomy is performed. In other words, the mucous membrane through a long period of evolution is abruptly transferred into an acid atmosphere after having been subjected to the environment of a constant alkaline secretion. Jejunal ulcer can occur, however, independent of any operative procedure, and give rise to perforation, as proven by the following case.

Francis O. Simpson, of the West Riding Asylum, Wakefield, England, reported a case of acute perforated jejunal ulcer in a man fifty-six years of age, who died, and in whom at autopsy a perforation of a jejunal ulcer about six centimetres from the duodenojejunal angle was found. This case has an interesting bearing upon the etiology of jejunal ulcer, since it is reasonable to assume that, if hyperacidity plays some part in the production of gastric or duodenal ulcer, it may, by creating an upper jejunal acidity, predispose to the development of jejunal ulcer.

The toxic action of the hyperacid gastric juice upon the cells of the mucous membrane causes protoplasmic destruction, the act of digestion being completed by the intestinal juices. This single agent associated with the traumatism to the mucous membrane of the jejunum, incident to the application of an intestinal clamp for the performance of gastro-enterostomy, must in itself be regarded as an important causative element. When the ulcer exists at the site of the anastomosis and is, therefore, gastrojejunal in type, there is no doubt but that the gastric hypersecretion and the wound made in effecting the anastomosis are the two factors largely responsible for this lesion. There is much discussion as to whether the mucous membrane at the suture line heals by primary or secondary intention, and of the relationship the suture material

JEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY

employed in making the anastomosis bears to the development of ulcer in the margin of the stoma. There is no doubt in the writer's mind, from a careful study of the subject, that the suture line does not heal by primary intention, and that the catgut employed on the mucous surface produces necrosis, and is either absorbed or thrown off, causing the stoma to reach to the seromuscular suture line. It is, therefore, obvious that healing takes place at the gastro-enterostomy orifices by primarily producing an annular granulating surface which quickly heals over and extends down to the seromuscular suture line. The toxic and digestive action of the gastric and duodenal juices upon an unhealed surface, over a long or short period of time, render possible the development of an ulcer. When the seromuscular suture line is made with a continuous strand of silk or linen, it has not been infrequently the experience at operation to find shreds of this material hanging in the orifice from the margin of the stoma. This foreign unabsorbable material acts as a "septic drain," retarding healing and maintaining constant irritation. Since, however, many cases are on record in which no suture material was found in the ulcer at operation, we must conclude that the use of an unabsorbable suture with danger of the shred becoming part of the gastro-enterostomy orifice, while an important contributing factor, is not the sole causative agent in the production of this pathological state. A continuous seromuscular suture may narrow the newly created opening by having a tendency to purse-string the gastro-enterostomy orifice, and this important agency in the production of ulcer at the anastomosis site must not be overlooked.

No doubt, after gastro-enterostomy for gastric or duodenal ulcer, hyperacidity in most cases is quickly relieved. There are cases, however, in which the hyperacidity persists for some time following the operation, and, when associated with indiscretion in diet, we have important predisposing factors in the development of gastrojejunal or jejunal ulcer. What relationship patency of the pylorus bears to the production of this type of ulcer we are unable to say, since closure of the pylorus forces the gastric contents to pass through the newly acquired opening in the stomach wall, while on the other hand there are those who maintain that pyloric or duodenal exclusion is unnecessary to the physiologic success of the operation, and therefore do not practise this procedure.

The studies of Rosenow have thrown so much light upon the agency of infection (*streptococcus*) as an important factor in the development of gastric and intestinal ulcer, that the evidence adduced by him cannot be disregarded in a discussion of the causation of this condition. In the

case of the types of ulcer under consideration, the ideal conditions exist for implantation of organisms upon a traumatized surface, in which circulatory interference has taken place from the application of clamps or as the result of suturing.

It should be noted that Patterson, in his very complete discussion of this subject, first insisted upon the classification of ulcers into two groups—(1) gastrojejunal and (2) jejunal ulcers—depending upon the location of the ulcer with reference to the anastomosis previously made and the etiologic factors relating to their origin.

In the first group, the ulcer is part of the stoma, developing on the suture line, and possesses the real causative elements, viz.: the open wound of the gastric and jejunal mucosa, plus the importance of the unabsorbed silk or linen suture and the hyperacid gastric secretion. In the second group of cases (jejunal ulcer), the important factor in the ulcer production is undoubtedly the contact of an acid secretion on a mucous surface, constantly bathed by an alkaline medium.

Diagnosis.—When symptoms suggestive of the primary lesion occur a year or more after a period of complete relief, and strongly suggest recurrent pathological activity of the gastric or duodenal ulcer previously operated upon, the clinical evidence should strongly suggest the possibility of a gastrojejunal or jejunal ulcer rather than a recrudescence of an ulcer which has probably healed following the operation. It is evident that the diagnosis of this unusual lesion, even when based upon clinical evidence of undoubted importance pointing to the primary lesion, can only be certified by operation and an examination of the gastro-enterostomatized site.

Since an abdominal tumor has been present close to the midline in the epigastrium in many of the cases, this evidence, supported by the clinical features of the case, is of much value in arriving at a correct conclusion. The tumefaction, however, has been frequently mistaken for some other epigastric lesion, and ulcer was not considered. In the future, careful and repeated gastric analyses indicating hyperacidity will be an important factor pointing to the presence of ulcer.

Radiologic studies of the stoma of gastro-enterostomatized patients have only recently been made for the purpose of diagnosing the presence of gastrojejunal ulcer. Carman and Balfour have recently summarized their studies of eleven patients examined by means of the Röntgen ray. They observed that ten patients showed abnormalities not customarily seen. The signs usually found were retention from a six-hour meal, large size of the stomach, exaggerated peristalsis and spasticity, and deformity of contour about the stoma. There was local irregularity of

JEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY

the jejunal contour, and some dilatation of the duodenum was also present. They regard marked deformity about the stoma as the most suggestive feature of gastrojejunal ulcer if associated with clinical evidence suggestive of the presence of this lesion.

Clinically there are two types of cases:

(1) In this class of cases the first symptoms immediately suggest an acute perforation of either the stomach or the duodenum, and the symptom-complex is characteristic of this grave abdominal catastrophe. Sudden, sharp, agonizing upper abdominal pain, accompanied by evidence of severe shock, with early board-like rigidity of the abdominal wall and a scaphoid abdomen, leaves no doubt in the observer's mind of the evidence of perforation. The pulse, during the first hours following perforation, is slow and full, and nausea and vomiting accompany the symptoms enumerated. The pain is intense and continuous, and little relief is afforded by the administration of morphine. The rigidity is often maintained even in the presence of deep ether narcosis. The absolute localization of the lesion in this class of cases can only be determined by immediate exploration, which should be the rule.

(2) In the group of cases where chronicity of symptoms is attended by the formation of protective adhesions about the ulcer site, acute perforation into the abdominal cavity does not occur. Tumor formation about the ulcer site may occur with adhesion to the anterior abdominal wall, stomach, colon, or small intestine, resulting in perforation and the establishment of a fistula into one of these structures. In one of Patterson's cases perforation took place into the anterior abdominal wall, and resulted in a jejunal fistula discharging on the surface of the abdomen. It is not unusual, from a survey of the cases reported, to find instances of perforation of the ulcer into the colon or small intestine. In the latter class of cases, radiographic examination, employing bismuth, will assist in clearing up the diagnosis.

In spite, however, of these various symptoms, the cases which have come to operation in this country have largely been patients in whom the clinical evidence of renewed activity of the primary lesion was suspected, and the pathology present was ascertained only by surgical operation.

Treatment.—The treatment of acute perforating ulcer of any abdominal hollow viscus is immediate operation, and the application of measures best adapted to the case in question. Closure of the ulcer is of greatest importance, and any other procedure will depend upon the conditions present. Dissociation of the gastro-enterostomy previously made may be all that is necessary combined with careful closure of the

openings in the stomach and intestine. This was practised in the writer's case (not acute perforation), and, since the primary duodenal ulcer had completely healed, there was no reason for performing a new gastro-enterostomy. The earlier cases reported, in which ulcer followed anterior gastrojejunostomy, presented a number of complications, such as fistula into adjacent organs or into the abdominal wall, and the surgical requirements were more extensive than they have been in ulcers latterly seen, especially in this country.

The necessity for suprapubic drainage following acute perforation will largely depend upon the amount of foreign material found in the abdomen at operation, and the time elapsing between perforation and exploration. When there is much soiling of the abdomen and beginning peritonitis is present, drainage should always be instituted. It should be the rule, however, in operating upon these cases to do as little as possible, since the separation of protective adhesions may open new avenues of infection, and disseminate foci which have been well localized and restricted by nature. Mayo, in a number of cases, has excised the ulcer and closed the gastric and jejunal openings, performing a new gastrojejunostomy when it has been deemed necessary.

Many cases, not acute in nature, which have come to operation have been those in which gastroenterostomy was done one to three years previously (some cases exceeding this period of time), and the primary lesion, either gastric or duodenal, has been found to have healed, and therefore the measures have been largely directed toward the relief of the symptoms produced by the complication at the gastro-enterostomy site. Closure of the jejunum, if the anastomosis has been made close to the ligament of Treitz, may be an extremely difficult procedure, since the distal limb of the duodenum, lying retroperitoneal and being immobile, cannot be delivered into the wound. Suture of the bowel should be either oblique or transverse with relation to its longitudinal axis, and every effort should be made to prevent narrowing of its lumen. Catgut should be employed and, if necessary, reinforced by interrupted seromuscular sutures of silk or linen. The latter should not penetrate the mucous surface of the bowel.

The prophylaxis of this condition entails the careful scrutiny of every patient's diet following the performance of gastro-enterostomy for gastric or duodenal ulcer. The immediate transformation from a long period of illness, occasioned by the ulcer present, into perfect health does not occur; and the digestive apparatus should not be subjected to unnecessary tests too soon. The administration of alkalis to overcome any hyperacidity remaining after the operation is advisable,

JEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY

and careful selection of articles of diet is likewise of much importance. Patterson is so strongly imbued with the importance of dietetic observation in his patients who have been gastro-enterostomatized for ulcer of the stomach or duodenum, that he does not advise meat as part of the diet for six months following operation. Small quantities of food at frequent intervals have a better physiologic effect upon the recently short-circuited stomach than three regular meals daily, consisting of an unlimited selection and quantity.

Since no cases of gastrojejunal or jejunal ulcer have been known to follow the pyloroplastic operation as devised and performed by Finney, this operation should have first place when it is indicated in the treatment of pyloric ulcer. The posterior no-loop gastrojejunostomy as performed in this country has shown fewer ulcers than any other operation save the Finney type. Theoretically, the performance of gastro-enterostomy without the use of clamps, thereby not traumatizing the mucosa of either the stomach or the jejunum, possesses more safety than the operation in which either the single or paired clamps are employed for holding the two structures in apposition. Interrupted seromuscular sutures of silk, linen, or catgut are preferable to the continuous suture which may persist, hanging in the stoma created. There are some surgeons who regard the suture element in the production of gastrojejunal ulcer of so much importance that they employ only catgut for all suturing in this operation. A large opening and either permanent or temporary blockade of the duodenum are of much importance in safeguarding against the development of ulcer at the stoma. At the present time, the question of duodenal closure by ligature, or unilateral exclusion, as practised by von Eiselsberg, is still a debatable question, if one may judge by the literature available upon this subject.

REFERENCES

- Barsony, T.: Beiträge zur Diagnostik des postoperativen jejunalen und Anas-tomosenukklus. *Wien. klin. Wochenschr.*, 1914, xxvii, 1050.
Bryan, Robert C.: *Surgery, Gynecology, and Obstetrics*, March, 1916, p. 279.
Carman, R. D., and Balfour, D. C.: Gastrojejunal Ulcers. *Jour. A. M. A.*, 1915, l, 15, 227.
Deaver, John B.: Personal communication.
Exalto, J.: Ulcus jejuni nach Gastroenterostomie. *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1911, xxiii, 13.
Finney and Friedlander: *Am. J. M. Sc.*, October, 1915.
Haberer, von: Ulcus pepticum jejuni. *Deutsche med. Wochenschr.*, 1913, xxxix, 724.
Jacobsons: *Operations of Surgery*, Sixth Edition, 1915, vol. ii, p. 175.
Lennander: *Nordisk. Med. Arkiv.*, 1907, x1, 97.

- Lieblein, V.: Jejunal and Gastrojejunal Ulcer after Gastro-enterostomy. *Centralblatt*, 4, f. d. gruzgeb. d. Med. u. Chir., 1915, xix, p. 64.
- Mayo, W. J.: *Mayo Clinics*, 1910-1914.
- Mayo, W. J.: Chronic Duodenal Ulcer. *Jour. A. M. A.*, 1915, lx, 4, 2036.
- Mayo, Chas. H.: *Mayo Clinics*, 1914, vol. vi, p. 102.
- Mayo-Robson, A. W.: Peptic Ulcer in the Jejunum. *Tr. Med. Chir. Soc., Lond.*, 1904, lxxxvii, 339.
- Mayo-Robson, A. W.: *Brit. M. J.*, January, 1912.
- Moynihan: *Abdominal Surgery*, last edition.
- Patterson: *ANNALS OF SURGERY*, Philadelphia, August, 1909.
- Pinner, A. W.: Über die perforation des postoperativen Ulcus jejuni pepticum ins Kolon transversum.
- Pearson, W.: Gastrojejunal Ulcer, With Report of a Case. *Tr. Roy. Acad. Med., Dublin*, 1912, xxx, 192.
- Roojen, P. H. van: Über das Ulcus pepticum jejuni nach Gastro-enterostomie. *Arch. f. klin. Chir.*, 1909, xci, 381.
- Rowlands, R. P.: Jejunal and Gastrojejunal Ulcers. *Guy's Hosp. Gaz.*, 1913, xxvii, 149.
- Schwartz, K.: Beiträge zur Kasuistik und Chirurgischen Therapie des peptischen jejunageschwürs. *Arch. f. klin. Chir.*, 1914, civ, 694.
- Schostak, T.: *Braun's Clinical Surgery*, vol. lvi, 1907-1908.
- Simpson, Francis O.: *Practitioner*, February, 1897, p. 165.
- Tiegel, M.: Über peptische Geschwüre des Jejunums nach Gastro-enterostomie. *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1904, xiii, 897.
- Wilkie, D. P. D.: Gastrojejunal and Jejunal Ulceration Following Gastro-enterostomy. *Edinb. M. J.*, 1910, 316.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting, held February 9, 1916

The President, DR. CHAS. N. DOWD, in the Chair

(SYPHILIS OF THE STOMACH—PYLORECTOMY

DR. JOHN DOUGLAS presented a man, aged sixty-five years, who had suffered from indigestion since he was twenty years old, associated with severe attacks of pain in stomach, irrespective of meals, for nine years. Pain so severe he could not sleep. Always worse when stomach was empty. Vomited frequently. Attacks of severe cramp-like pains occurred at any time during day, causing vomiting. Frequently vomited large quantities of blood, sometimes more than a litre. Had a large hemorrhage just before entering hospital. Had lost a great deal of flesh and strength and appears cachectic. Radiographic examination shows filling defect of lesser curvature and large residue. Diagnosis of carcinoma made from radiograph. Gastric analysis showed no free HCl and presence of lactic acid. Wassermann 14-unit positive, although no history of syphilis could be obtained.

Patient was kept on antiluetic treatment with salvarsan and Hg injection for twenty-four days; then, as pain continued, and on account of his age, and symptoms pointing to the possibility of carcinoma developing on the base of a luetic ulcer, as is known happens in the tongue and other regions, operation was performed.

Pathological Findings.—Two small ulcers, one a little more, the other somewhat less, than 1 cm. in diameter, found on the anterior wall of the pyloric portion of the stomach, near the lesser curvature, surrounded by an area of induration, involving most of the anterior wall of the pyloric portion of the stomach.

Operative Procedure.—Bellevue Hospital, July 30, 1915. Pylorectomy by the Billroth No. 2 method.

Pathological examination showed no evidence of carcinoma. Convalescence was uneventful and at present, six months after operation, has no stomach symptoms and has gained forty-one pounds in weight since leaving the hospital.

NEW YORK SURGICAL SOCIETY

GASTRIC ULCER—EXCISION

DR. DOUGLAS presented a man aged fifty-two, who for four years had suffered from severe pain in the left epigastrium, spreading into the back, two or three hours after eating. Never vomited or conscious of sour stomach. Pain at first relieved by soda bicarb., later not. Never had night pains or hunger pains and felt better when lying down. Not very constipated, but occasionally took laxatives. Radiographic examination, negative, except for six-hour residue. Gastric analysis showed free HCl, 10; total acidity, 20, no blood. Wassermann negative.

Pathological Findings.—Ulcer of lesser curvature about 4 cm. from pylorus.

Operative Procedure.—St. Luke's Hospital, November 10, 1915. Excision of ulcer. Perhaps for an ulcer as small as this specimen now looks the Balfour method of cauterization would have been an equally effective method of removal, with less deformity or interference with the normal contour of the stomach; but in the presence of active ulceration, surrounded by a considerable area of inflammatory cedema, which made the ulcer appear much larger than it now looks, excision seemed the safer procedure.

Present Condition.—Two and one-half months after operation. Patient has gained in flesh and strength and has none of old stomach symptoms or pain. Is constipated, however, and when markedly so has abdominal cramps, and radiographic examination made within the last few days shows that a gastric residue still remains, although there did not at the time of operation, or even from the present radiographs, appear to be much shortening of the lesser curvature, resulting in the fish-hook deformity commonly occurring after extensive V-shaped resection of the lesser curvature. Radiographs also show the presence of an ileal stasis. Dr. Douglas said that it was his belief that it is desirable to excise ulcers in this location, especially in a patient of over fifty years of age, both for the cure of the ulcer and to remove the possibility of the presence of or subsequent development of carcinoma, which most frequently develops in this part of the stomach wall.

DUODENAL ULCER—EXCISION

DR. DOUGLAS presented a woman, aged twenty-six years, who gave a typical history of duodenal ulcer for past two years, during which she had five distinct attacks, with periods of remission. Attacks characterized by indigestion and pain radiating into back, usually about two

DUODENAL ULCER

hours after meals. Pain sometimes relieved by vomiting, but would return when stomach was empty. During worst part of attacks had hunger pains and tenderness in epigastrium, relieved by eating, but not by sodium bicarb. Radiographic examination negative, except for six-hour stomach residue. Gastric analysis showed free HCl 60, total acidity 88. No blood. Wassermann negative.

Pathological Findings.—A small ulcer about $\frac{1}{2}$ cm. in diameter on anterior wall of first portion of duodenum.

Operative Procedure.—St. Luke's Hospital, December 19, 1915. The only evidence of ulcer was a small area which could only be indefinitely seen or palpated in the duodenal wall, and as its presence could not be positively determined an incision was made into the duodenum, which demonstrated its crater on the mucous surface. The ulcer was excised and the duodenal wall sutured.

Present Condition.—Six weeks after operation. No stomach symptoms.

It was of interest to note that radiographic examination sixteen days after operation showed no gastric residue or evidence of duodenal deformity.

The patient was presented to emphasize the importance of an incision into the duodenum to determine the diagnosis, if necessary, and to illustrate the ease and advantage of excision of the small ulcers occasionally found on the anterior wall of the duodenum.

DR. CHAS. N. DOWD said that warning may be given in regard to the excision of ulcers, especially those in the lesser curvature of the stomach. A small scar may represent a very extensive cicatricial contracture, and hence the rent which remains after the excision of such a scar may be enormous, necessitating an elaborate closure. In view of this, the Balfour method of cautery puncture is often a better procedure than excision.

As to the desirability of gastrojejunostomy in addition to excision, it seemed to him that it is generally desirable. Experience has shown that the chemical and mobile changes which follow this procedure are very desirable.

DR. DOUGLAS said that there is one point in regard to doing gastroexcision rather than enterostomy in these cases. It was that which had impressed him in all of them, even the one with syphilitic ulcer. There was a very considerable amount of induration and thickening of the wall of the stomach in the latter, but he could not find any mechanical obstruction of the pylorus. It was the same with the case of duodenal ulcer. There was no spreading of the induration or inflam-

mation about the ulcer, either in the duodenal case or in the gastric case, that appeared to interfere mechanically with the action of the pylorus. There must be, just as in some cases of chronic appendicitis, occasions when there is a reflex cause for the residue shown by all of these patients before operation rather than mechanical obstruction. He did not see very much reason, then, for doing a gastro-enterostomy in all cases if the cause of the reflex irritation is removed and the pylorus not interfered with mechanically by the operative procedure.

The patient with the ulcer of the lesser curvature still has his residue, however, and he thought the result would have been better had a gastro-enterostomy been done in addition to excision, and that this procedure is advisable in similar cases.

The reason for doing a pylorectomy in the third case was on account of the age of the patient, over sixty, suggesting the possibility of carcinoma.

LATE CHANGES FOLLOWING OPEN REDUCTION OF FRACTURE— DISLOCATION OF SHOULDER

DR. WILLIAM DARRACH presented a man, thirty-eight years of age, who had been thrown from a wagon, landing on his shoulder. Three days after the injury he came to the Roosevelt Hospital. The humeral head could be felt below the coracoid, rotating with the shaft. There was no crepitus. Under ether an attempt was made to reduce the dislocation without success. X-ray showed the head still out of the glenoid. A second and third attempt were likewise in vain, and after the last attempt, when traction had been used with the heel in the axilla, a complete motor paralysis of the whole extremity was noted.

He was then admitted to the ward, and on the twenty-third day after the injury an open operation was performed. Under gas and ether, a curved incision was made from over coracoid outward and downward for a distance of 5 inches. The curved flap was lifted up and the deltoid separated from the pectoralis major. The anterior fibres of the deltoid were then cut 1 inch from their clavicular attachment, the subdeltoid was divided to the outer side of the coracoid head of the biceps, exposing the site of injury. It was found that the lesser tuberosity had been torn off by the subscapularis, but had maintained its attachment to the periosteum below, the latter being stripped off from the upper portion of the humeral shaft. The outer shell of the greater tuberosity had also been torn away from the bone, but had also maintained its muscular and periosteal attachment. Thus the head and upper shaft had been separated from both tuberosities and the

OPEN REDUCTION OF FRACTURE

periosteum had been forced forward out of this sleeve and assumed a subcoracoid position. The lesser tuberosity lay interposed between the glenoid and the head and prevented reduction. The long tendon of the biceps was displaced behind the humeral head. The vessels which enter the humerus through the numerous foramina at the anatomical and surgical necks were all torn away. This factor explains to a large extent the subsequent changes in this shoulder.

By lifting the lesser tuberosity forward from its glenoid position and holding out the biceps tendon and greater tuberosity, the head was made to return to its normal position in the glenoid and was again surrounded by its tuberosity-periosteal sleeve. The rent in the latter, as well as the capsular tear, was repaired with chromic catgut. The cut deltoid was sutured with the same material and the skin with silk and a Velpeau bandage applied.

There was primary union of the wound and movements were not begun until three weeks after operation. The motor paralysis rapidly disappeared except for the triceps and deltoid, which did not regain their function for about four months. At the end of six months he was back at work and continued to improve for about a year. After a stationary period of several months he noticed a gradual decrease in the amount of abduction, which had reached about 60° , and of rotation. Coincident with this decrease in motion there appeared a grating in the joint, but almost no pain. Since that time there was a gradual increase in the grating and in the limitation of motion until one year ago.

Since then the process has been stationary. During this period X-ray examination has shown a gradual atrophy and flattening of the head. At present there is about 20° of abduction with only 25° of rotation at the gleno-humeral joint. He can raise his arm to within 10° of the horizontal and is able to continue his trade at full wages, though he says he cannot lay bricks above the level of his head.

The late appearance of these arthritic changes in the joint and their slow progress over a period of four years have been most interesting.

It is believed that the destruction of such a large proportion of the blood supply (and possibly nerve supply) of the humeral head, at the time of the accident, has been a potent etiological factor in this condition.

DR. HOWARD LILIENTHAL believed that it was safer to remove loose pieces of bone than to try to anchor them in position and secure an ideal anatomical result. A practically perfect functional result may be obtained even if the fragments are taken out.

In one case, which he reported some years ago, in which there was a complete separation of the head of the bone, he took the loose head

of the humerus out, and got an absolutely perfect result, so that two years afterwards the man was able to move that arm as well as the other one; could put on his coat and put his arm up over his head.

As Dr. Darrach has suggested, this danger of absorption of bone is a real one, on account of lack of blood supply.

DR. CHAS. N. DOWD said that in considering Dr. Darrach's case of fracture dislocation of the upper end of the humerus there is given an opportunity to study the late changes which may follow this injury, an opportunity which does not often come. This bears on the problem of removal of the head of the bone when it has been separated from the shaft and is dislocated.

Most surgeons have made efforts to preserve the head under these circumstances and the results have not always justified the effort. If the replaced fragment is likely to atrophy, and if the upper end of the shaft is likely to give good function without this fragment, one need not make prolonged efforts at reduction but will be wiser to simply remove the fragment.

DR. DARRACH said that until about two years ago he was very enthusiastic about the open reduction in cases of fracture dislocation of the shoulder. Since then, having seen this and three other late cases, he was not quite as enthusiastic as he was; and yet in two cases of this kind, he had had results that are really far better than they would have been had the head been resected.

A fracture-dislocation of the shoulder is a great deal more common than had been supposed. He thought that almost all of the shoulder dislocations that can not be put back with very careful attempts are complicated by some fracture, and the usual type is a tearing-off of the greater tuberosity alone or tearing with that of the lesser tuberosity.

Very frequently it is a mere shell of bone which comes off, and it may not be thick enough to throw any shadow with the X-ray. In most of the lesser tuberosities he had seen, it does not show up in the X-ray at all; so it is a fair guess, if the dislocation does not go back at an early attempt, to say that one or both of the tuberosities are broken off.

As to removing loose fragments, if the fragments are actually loose, it is a very good rule to follow, but in such a case as this was, where the tuberosity was torn off the bone and yet maintained its periosteal attachment, and also the attachment of the rotating muscles, the case was different.

If, however, there is a small fragment, as seen in some of these greater tuberosity breaks, which is simply tilted out a little bit, so that



FIG. 1.—Change in shape of thigh caused by exostoses of femur.



FIG. 2.—Exostoses of femur and of tibia.



FIG. 3.—Exostoses of humerus.



SEPTIC INFARCT OF THE LUNGS

it presents a rough surface, projecting into the subdeltoid bursa, that fragment ought to be removed. Only in that way can one stop a bursal irritation.

In the dislocations of the shoulder with fracture, or in dislocations alone, where the head has been out for any length of time, that is, if it has been out for four or five or six weeks, or even six months, a better result can be secured by taking out the head than by reducing it; but in the early cases there is a distinct field for the open reduction.

MULTIPLE CARTILAGINOUS EXOSTOSES

DR. ALEXIS V. MOSCHCOWITZ presented a man, thirty-one years of age, who was referred to him by Dr. Lefkovics, December 3, 1915. His principal complaints were pain and a peculiar sensation of persistent coldness in the left leg and foot; in addition, he also complained of inability to walk in comfort for more than a block or two. He was aware of the existence of a tumor upon the back of the corresponding thigh for a period of eight years, which had increased but very slowly in size. He had not noticed any other tumors, or at least he had paid no attention to same.

On physical examination it was seen that the patient was somewhat short in stature, with very well-developed muscles. The left popliteal space was occupied by a tumor the size of a grape-fruit, which was of a bony consistence and was attached to the posterior surface of the femur (Figs. 1 and 2). A number of other tumors were also found scattered throughout the body. Upon subsequent X-ray examination they were able to count forty-three (Fig. 3). The tumor upon the left femur caused pressure upon the popliteal vein, as was evidenced by a cyanosis, and a sensation of cold in the foot.

The man was operated upon December 10, 1915, at the Har Moriah Hospital. As is usual in these cases, a bursa covered the exposed cartilaginous surface of the exostosis.

Both objectively and subjectively the patient has been well ever since the operation.

SEPTIC INFARCT OF THE LUNGS FOLLOWING APPENDICITIS

DR. ALEXIS V. MOSCHCOWITZ presented a man, twenty-five years of age, who was admitted November 24 to the Har Moriah Hospital, suffering from an acute appendicitis, and was operated on November 5. A gangrenous perforated appendix, buried in old adhesions, and surrounded by an abscess cavity containing about one ounce of foul-

smelling pus, was extirpated; the abscess cavity was drained by a cigarette drain.

The subsequent course for one week was absolutely uneventful. The slight temperature, 99° – 100° F., could very well be accounted for by absorption from the abscess cavity. The patient was considered absolutely out of danger and convalescent, when on the seventh day he had a chill, followed by a temperature of 103° F. On careful examination there was found a small patch of dulness over the lower lobe of the right lung, posteriorly, near the vertebral column, with bronchophony and bronchial breathing. A pneumonia was diagnosticated at first, but the subsequent course of the temperature, the repeated occurrence of chills, etc., soon changed the diagnosis into that of a septic infarct of the lung. This was verified subsequently also by X-ray examination. Repeated aspirations failed to reveal any pus; a little cloudy fluid withdrawn from the pleural cavity showed the presence of Gram-positive diplococci. One week later the temperature dropped to normal and did not rise thereafter. During the week with febrile symptoms the patient was critically ill, and the outlook was very precarious; but, after the fever stopped permanently, the convalescence was very rapid; the physical signs, however, persisted for a very long time.

FOREIGN BODIES IN THE RESPIRATORY TRACT

DR. N. W. GREEN read a paper, with the above title, for which see page 656.

Stated Meeting, held February 23, 1916

The President, DR. CHAS. N. DOWD, in the Chair

OBLITERATING THROMBO-ANGIITIS ACCOMPANYING LEAD POISONING

DR. CHAS. N. DOWD presented a man whose leg he had amputated six inches below the knee for obliterating thrombo-angiitis. The etiology of the condition was remarkable—most of the patients seen with obliterated arteries are natives of Russia or adjoining locality, in early manhood. This man is an American, a house-painter, age thirty-six, who was apparently in good health until two and a half years ago, when he noticed symptoms of intermittent claudication in the calf of his left leg. He could walk only about half a block at a time without great pain and the necessity of resting. The symptoms continued about the same until eleven months ago, when he ceased walking, excepting with

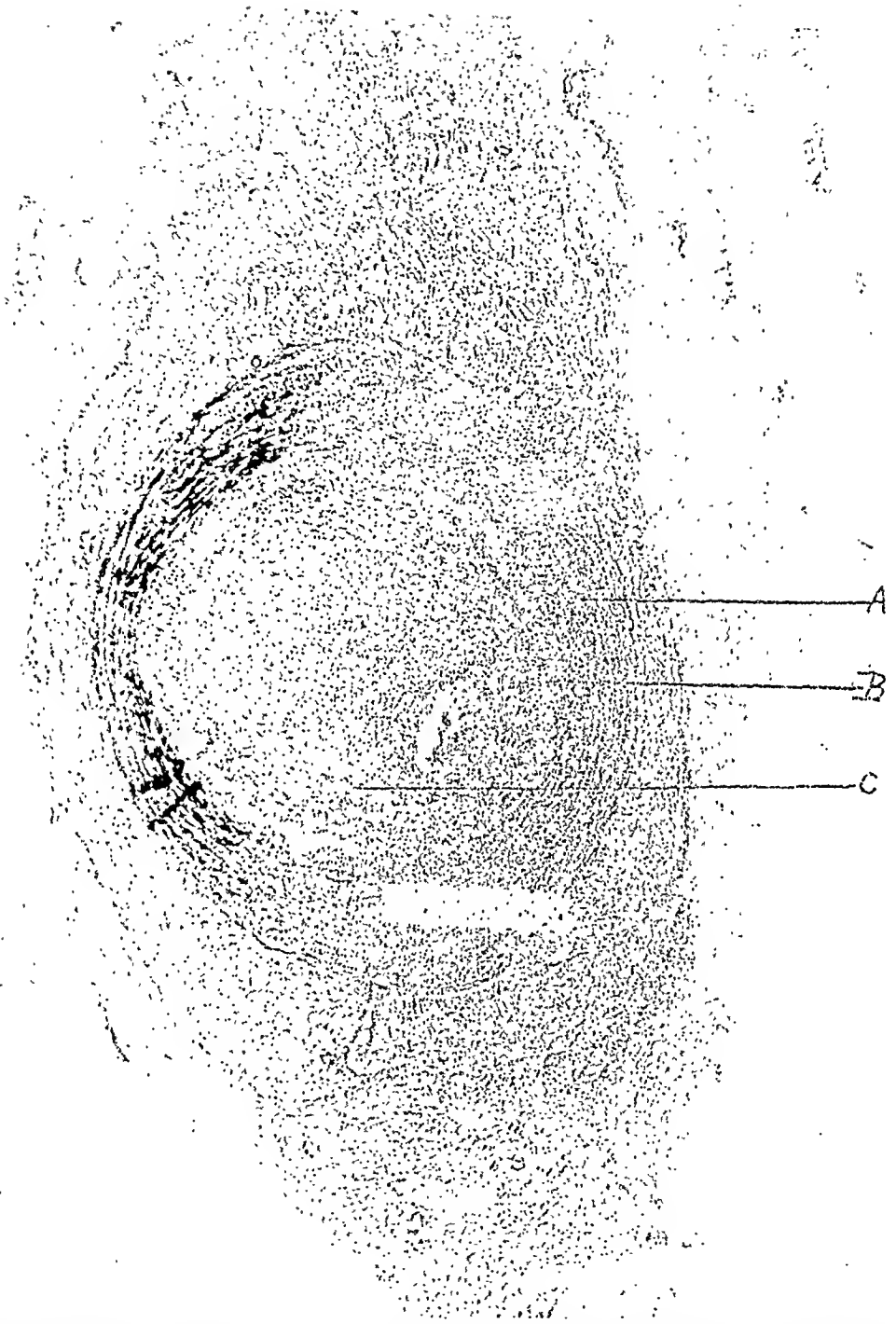


FIG. 1.—Microphotograph of transverse section of posterior tibial artery, showing thromboangiitis obliterans. A, media infiltrated with connective tissue; B, connective tissue replacing the intima; C, organized deposit of fibrin containing giant-cell.

a cane and crutch. Thirteen months ago he noticed a small blood blister under the left little toe which stung and burned. It was opened two months later and has kept on sloughing since. At one time he was given hot electric light baths on the foot and the wound healed, excepting a very small spot. It was always very sore and at present pains severely at night. Last October the ulcer was operated upon and curetted. Instead of healing it has kept on sloughing. Then the small toe began to slough away and the pain was so severe that a portion of the metatarsal bone was also removed on December 8. The sloughing continued as before and now the next toe and the tissues at the base appear gangrenous.

He was sent to the Roosevelt Hospital from the Neurological Institute with the diagnosis of endarteritis due to lead poisoning, and lead had been found in his urine.

He had worked at his trade as a painter for twenty years and had not known that he had lead poisoning, although he had a dark line along the dental border six months ago.

No alcoholic or venereal history: he smokes about three ounces of tobacco a week.

His condition was found to be good, excepting his left leg, which was thinner than the right. No pulsation could be felt in the left femoral artery or its branches, although there was good pulsation in the arteries of the right leg.

There was an ulcer with gangrenous base involving the fourth left toe and adjacent part of the foot. The fifth toe and metatarsal bone were absent.

Wassermann reaction negative. Pupils slightly uneven in size but react both to light and distance. Reflexes normal. Blood-pressure in both arms, 132.

He suffered intense pain in his left leg and foot at night, and after a few days of observation amputation was done six inches below the knee. The selection of the site for amputation was not easy, since we had had no experience with the obliteration of arteries from plumbism and found no one who had. It seemed fair, therefore, to follow a conservative course, and amputate below the knee. There was very little bleeding in the flap and healing is tardy, but will probably be secured. The aperiosteal method was used, and even now he can bear considerable pressure on the stump, excepting at one part of the suture line, which is still open.

The recent studies in industrial welfare have added much to our knowledge of lead poisoning. Its manifestations are manifold; the

nervous system is especially likely to be affected and the symptoms are dependent upon the site of the lesion. Sir Thomas Oliver's monograph¹ gives the details of extensive observations.

Vaughan² and V. Schrötter³ refer to the obliterating endarteritis which accompanies the disease.

The microscopical appearance at a cross-section of one of the arteries is shown in the accompanying microphotograph. The organized central thrombus, the thickened media and the replacing of the intima by connective tissue are all shown. Dr. Mortimer Warren's pathological report is appended.

Sections.—Six, of anterior and posterior tibial arteries. Vein and nerve.

Microscopic Examination.—(A) Sections show small bundles of nerve tissue in which there is a moderate amount of connective tissue between the nerve fibres. Several small arteries and acini seen which seem to show considerable amount of connective tissue in the media.

(B) Shows cross-section of artery. The lumen is filled with a well-organized deposit of fibrin containing one giant cell. The intimal endothelium is gone; the intima itself replaced by a generous amount of connective tissue. The media shows wide separation of muscle bundles due to infiltration of connective tissue.

Microscopic Diagnosis.—Interstitial neuritis; endarteritis obliterans.

A chemical and electrolytic examination of the muscles of the amputated leg was made at the Neurological Institute and much lead was found in them.

AMPUTATION STUMPS

Dr. Dowd presented a man, age thirty, whose leg he had amputated by the aperiosteal method for an extensive basal-celled epithelioma. The amputation was at the junction of the middle and lower thirds of the thigh. As soon as healing was complete, bathing, massage and pressure were applied by the method which Dr. Lyle has advocated. He left the hospital three weeks ago, wearing a peg-leg with a plaster-of-Paris socket fitted for an end-bearing stump. He stood the pressure well and walked well. He returns this evening with a crutch instead of his peg-leg, saying that a tender spot had appeared at the side of the stump, but the end of the stump is good and he can endure much pressure there without pain. The stump was better than the average and furnished a good possibility for an artificial leg which would utilize the "end-bearing" principle.

¹ Sir Thomas Oliver: Lead Poisoning, New York, 1914.

² Victor C. Vaughan: Forschheimers Hoeber Therapeutics.

³ V. Schrötter: Notlnagel's Handbuch.

Dr. Dowd said that he thought that stumps must be adjusted to the conditions present at the time of operation. Personally, he saw very few amputations with clean, well-nourished stumps. Most of the amputations are done for tuberculosis or for obliterating thrombo-angiitis. In the former, infection has usually spread into tissue which should be preserved, and in the latter the circulation is usually imperfect. Last year, after Dr. Lyle brought this subject before the society, he amputated at the thigh for tuberculosis of the knee of very long standing, pushing back 1 cm. of periosteum and scooping out a corresponding amount of marrow. There was a delay in the healing, and finally a ring of bone came away, which represented the end of the femur, from which the periosteum had been removed. Since then he had pushed back very little periosteum and had hardly touched the marrow. He did not think this case an argument against the aperiosteal method, but did consider it an indication that in badly-nourished bones neither the periosteum nor medulla should be widely disturbed.

DR. H. H. LYLE said that Dr. A. Moschowitz had shown such a case before this society. Since then Dr. Lyle has been removing only .5 cm.; formerly he removed 1 cm. Reports of circular sequestration of the stump end occurring in the periosteal method are not uncommon. Dr. Lyle said he considered the osteoplastic the ideal method, given ideal conditions. Given infected conditions, the aperiosteal is ideal. It is possible to get an end-bearing stump in a large per cent. of the infected cases if the aperiosteal method is employed.

DR. WALTON MARTIN said that he believed the aperiosteal flap gives a better stump than the periosteal flap. Infection, however, plays a very important part. He remembered one of the cases shown by Dr. Lyle; there were several long, sharp, bony spurs and a pus-discharging sinus in the end of the stump. It was a good example of one of the effects of infection in an amputation stump. It seemed to him that rough handling of the periosteum and the tearing away of the muscular attachments is also important.

He has recently had experiences which bear out the statement that instrument makers prefer artificial limbs which do not bear weight on the end of the stump. They often prefer an amputation being done higher than is necessary, so that a complete limb may be used, supported from the pelvis rather than lower down. One reason for this is, that these ingenious devices show the skill of the instrument maker to greater advantage.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting, held February 7, 1916

The President, DR. CHARLES H. FRAZIER, in the Chair

TOTAL CYSTECTOMY ONE AND A HALF YEARS AFTER OPERATION

DR. B. A. THOMAS presented a man, aged forty-two years, who was first cystoscoped by him January 23, 1912, on account of frequency of urination and dysuria. At that time small nodules or tubercles were discovered on the posterior aspect of the vesical sphincter. A few days later these were removed and a pathologist reported them to show "inflammatory changes but no evidence of tuberculosis." The patient was temporarily relieved but in a few weeks his symptoms returned with greater severity, and he was treated for over a year by several physicians, being cystoscoped frequently, both with and without general anæsthesia. His treatment consisted mainly of prostatic and vesical neck "punch operations," "fulgurations" or high frequency electro-coagulation, suprapubic cystotomy, etc. On September 30, 1913, he again came under the care of Dr. Thomas. At this time the patient's condition was deplorable. He was obliged to urinate very frequently with excruciating pain; had been utterly incapacitated from work for a year and a half, and threatened suicide.

Cystoscopy done at this time at the Polyclinic Hospital revealed multiple, variously sized, small tumor formations completely covering the trigonum and vesical neck, obscuring the ureteral orifices from view (Fig. 1). A few of these growths were removed by the cystoscopic rongeur for histo-pathological examination, and were reported by Dr. John A. Kolmer to be "inflamed polypi." On November 11, the bladder was opened suprapubically and the entire trigonum and vesical orifice thoroughly cauterized with the actual cautery. The patient was relieved for a month or six weeks, when his symptoms returned, and cysto-urethroscopy demonstrated the presence of reforming polypi about vesical orifice and in prostatic urethra. In view of the generally poor results following ureteral transplantation into the rectum, it was decided to perform bilateral nephrostomy, supplemented by total cystectomy. The left kidney was nephrostomized January 13, 1914; the right,



FIG. 1.—Cystoscopic appearance of multiple inflamed polypi covering trigonum and vesical orifice.

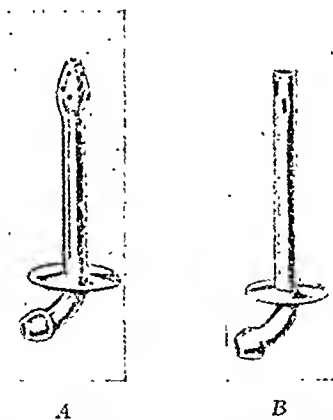


FIG. 2.—One or the other of these sterling silver tubes is placed in the renal fistula and the tract permitted to granulate around it. Should phosphatic incrustations occur to interfere with the drainage, the tube must be removed for cleansing; in which event the bulbous expansion is not practicable, and tube *B* should be substituted and held in position by adhesive plaster. In order to make the drainage water-tight, the tube may be expanded conically for a short distance above the circular flange.



FIG. 3.—Posterior view of renal drainage apparatus. The silver tubes here shown are the same as A (in Fig. 2). By expanding the tube near the flange and securing same close to the skin, the apparatus may be made almost, if not quite, water-tight.

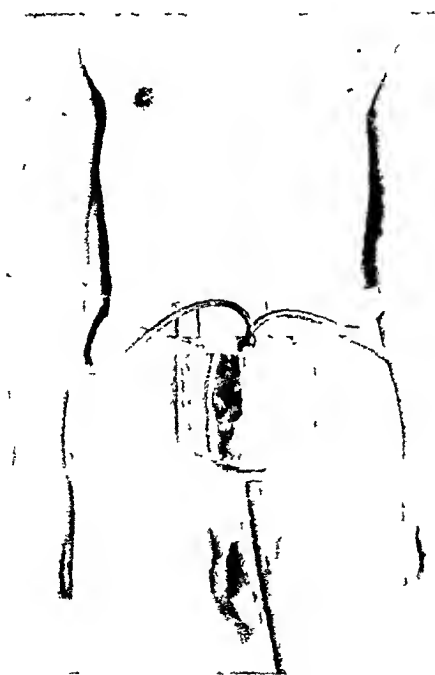


FIG. 4.—Anterior view of drainage apparatus, showing receptacle suspended over suprapubic region. The tubing attached to the bottom of the reservoir may or may not be utilized.

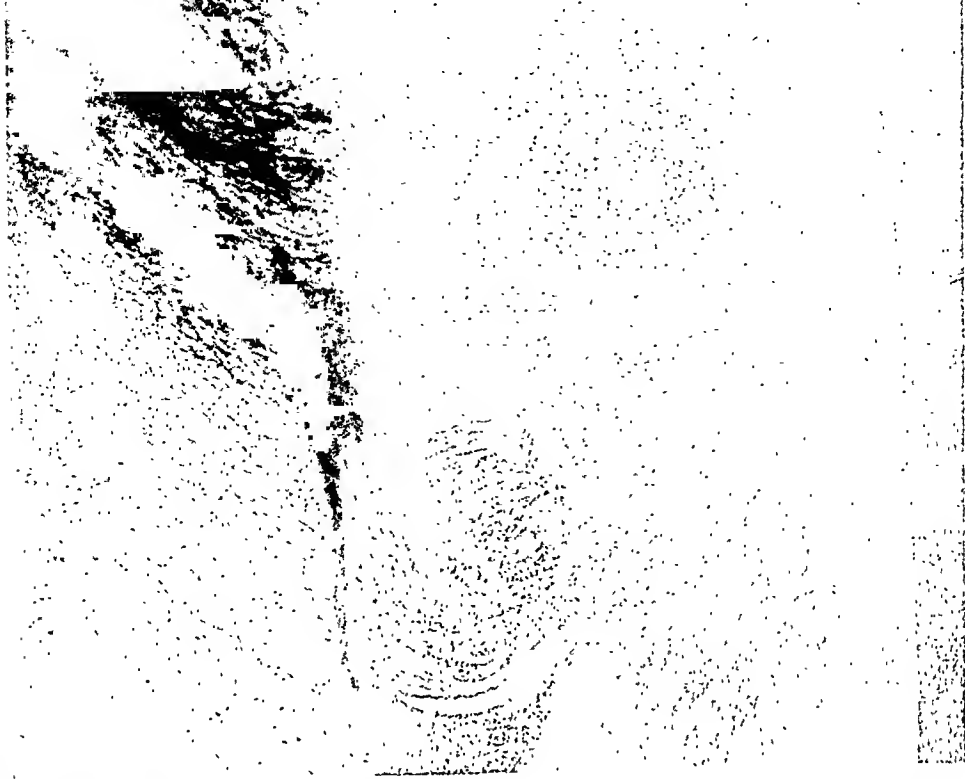


FIG. 5.—Carcinoma of penis of nine months' duration with metastasis to right inguinal lymph nodes.



FIG. 6.—Appearance of external genitalia four and a half years after amputation of penis for carcinoma. Patient can urinate in erect posture quite satisfactorily.



AMPUTATION OF PENIS FOR CARCINOMA

February 24. The patient was markedly relieved after these operations for several months, save that he had to have his left ureter re-ligated with silk, the original catgut ligature becoming absorbed and permitting of partial patency of the ureter. On November 6, 1914, total cystectomy was done, the patient showing a remarkable convalescence. Four months later he began to complain of discomfort in the perineum and pain, referred down the urethra, associated with a slight mucopurulent discharge from the meatus. Suspecting involvement of the prostatic urethra and realizing from the beginning that the prostate was very slightly enlarged, a radical perineal extracapsular prostatectomy and posterior urethrectomy were performed. In order to minimize the danger of recurrence of these growths, 50.5 mg. of the element radium were implanted deeply in the perineum for 48 hours.

The renolumbar fistulæ have been fitted with sterling silver tubes (as shown in Fig. 2). These are connected with light rubber tubing to a flat metal receptacle suspended over the suprapubic region (Figs. 3 and 4). Thus equipped this man has been in good general health and practically free from pain for months; has little difficulty in keeping himself dry; requires dressing but once a week, excepting what he can do himself; goes about in- and out-of-doors at his leisure, and is able to do light work in comparative comfort.

The reporter thought this case to be worthy of record, not only as vindicating the feasibility of Watson's suggestion made in 1906, but because it marks the first instance in which the procedure has been successfully accomplished, and illustrates the practicability of the utilization of a satisfactory renal drainage apparatus.

AMPUTATION OF PENIS FOR CARCINOMA: CONDITION FOUR AND A HALF YEARS AFTER OPERATION

Dr. B. A. THOMAS presented a man, aged fifty-eight years, who came to the Polyclinic Hospital in October, 1911, with a typical carcinoma of the glans penis, involving the urethra, with metastasis to the inguinal lymph-nodes on the right side (Fig. 5). He stated that he had noticed the lesion on penis for nine months. The inguinal lymph-nodes in both groins were thoroughly removed and the penis amputated as close to the pubic arch as possible. Dr. John A. Kolmer, who examined the specimens pathologically, reported "carcinoma of the penis with metastasis to at least one lymph-node."

The patient convalesced satisfactorily and when seen last, February 7, 1916, had gained 40 pounds in weight, enjoyed excellent health, worked every day, and showed no signs of recurrence or metastasis (Fig. 6).

The case is of interest, first, owing to the fact that the patient has been free of any signs of recurrence or metastasis for $4\frac{1}{2}$ years, although at the time of operation metastasis was present in the inguinal lymph-nodes; second, because complete extirpation of the penis with perineal urethrostomy was not done, necessitating the patient to sit down in order to urinate; and third, because the patient can urinate quite satisfactorily in the standing posture.

DR. E. H. SITER said that of 12 cases of cancer of the penis that had been under his observation, 2 were inoperable; 10 were operated upon. In 2 of these operated cases an amputation was done and in the other 8 a total extirpation, including the scrotum. The best interests of the patient in these operations, he thought to be served when the urethra is brought out in the perineum. There is better control and no excoriation. After total extirpation of the entire genitalia there was a smaller percentage of recurrence.

Some five years ago he operated upon 2 cases in Blockley, doing a total extirpation. These patients he had seen within six months and they have had no recurrence. Where only an amputation was done he had invariably had recurrence.

DR. ALEXANDER RANDALL said that carcinoma of the penis presents many phases of difference from carcinoma elsewhere. Metastasis and the time of recurrence in carcinoma of the penis are apparently very late. The apparent immunity of the circumcised is peculiar to all. In 100 cases reported by Barney in the ANNALS OF SURGERY for 1907, some interesting points were brought forward. He found 85 per cent. of the cases had congenital phimosis, about 60 per cent. had carcinoma in the inguinal glands, and that 75 per cent. had enlarged inguinal lymph-glands. The growth was an epithelioma in practically every case. There were 26 recurrent cases in this series. Under one year there were 12 cases, or 39 per cent.; from 1 to 2 years, 6 cases, or 19 per cent.; from 2 to 3 years, 5 cases, or 16 per cent.; 3 to 4 years, 2 cases, or 6 per cent. In from 4 to 5 years there were no recurrences. After five years there was recurrence in 12 per cent. He likewise shows that a patient may live over 11 years from the time of onset of the cancerous growth. The operation of choice is the operation of Nicoll, published in 1909, which is more surgically a cancer operation like that used in carcinoma of the breast, because he takes out the inguinal glands and lymph-channels down to the dorsum of the penis and the penis itself, all in one piece, starting outside the zone of cancer and working towards the primary growth, making a complete resection of all involved tissue. This is the ideal operation, rather than that of amputation of the penis,

FRACTURE OF FIRST LUMBAR VERTEBRA

and just a single excision of the glands on either side, through separate incisions.

FRACTURE OF FIRST LUMBAR VERTEBRA WITHOUT NERVE SYMPTOMS

DR. FRANCIS OLCOTT ALLEN said that among the patients at the Insane Department of the Pennsylvania Hospital there was found a woman of forty, small, slightly built, but physically well. About midnight, June 18, 1915, she managed to get out of a second-story window and dropped to the ground, some twenty or twenty-five feet below. From an examination of the soft earth under the window, it was apparent that she had landed on her feet and then on her buttocks. She got up and made her way across the grounds for a distance of several hundred feet. She was then overtaken, brought back and put to bed.

He saw her about an hour and a half after this escapade. She was sitting up in bed, talking incessantly, entirely preoccupied with her own ideas, and paying no attention to the severe injury she had sustained. Examination revealed a marked swelling of the soft parts in the lumbar region, with a distinct kyphosis. This area was tender and gave some pain on certain motions of the trunk. No paralysis or other signs of a cord lesion could be made out. A skiagram was taken the next day and showed a fracture of the first lumbar vertebra. Owing to the disturbed mental state the patient was allowed to do as she pleased, as far as her injury was concerned, sitting up in bed most of the time, until she was able to be about. Her mind gradually recovered and she returned to her home, where she now is assisting her husband in a bakery. At a further examination made January 17, 1916, just seven months after injury, there was found a distinct kyphosis in the region of the first lumbar vertebra, with ankylosis of the adjacent spine. There was some tenderness over the spine just below the kyphosis, but no other physical findings were noted. The patient said that her injury did not prevent her from doing her work or anything she wanted to do. She complained of some pain in the lumbosacral region, of a sense of weakness when she did not wear corsets, and of her back feeling tired at night after doing her work in the bakery. Dr. Bowen reports on a skiagram made the same day:

The body of the first lumbar vertebra is considerably deformed but there is no evidence of the previous line of fracture. This vertebra will eventually be ankylosed with the twelfth dorsal and the second lumbar. A considerable part of that process is already accomplished.

The interesting feature of this case is, of course, that the cord and spinal nerves escaped even temporary injury. The spinal cord proper ends at the level of the lower part of the first lumbar vertebra, but through the canal of the first lumbar there also pass the nerves supplying sensation as high as the groin, and motion to the legs below the knees, as well as control of the bladder and rectum. In injuries of this portion of the spine, some or all of these functions are usually affected, and it is extraordinary that, in as marked a bony lesion as this patient presents, there should not be sufficient impingement upon the canal to cause pressure upon the nerve structures.

DR. HENRY R. WHARTON had had under his care two cases of fracture of the lumbar vertebræ which presented no marked symptoms of spinal injury. One was the case of a young woman of eighteen years of age who fell under a trolley car. There was marked kyphosis and a little evidence of loss of power in the lower extremities; some anæsthesia of the anterior surface of the thighs. The other case was that of a woman of twenty-five who jumped out of a burning apartment house in West Philadelphia, alighting on a bank of snow. He saw her a short time after the accident. There was fracture of the second lumbar vertebra, as shown by X-ray examination, and marked kyphosis. The only symptom of spinal injury was anæsthesia of the anterior surface of the thighs. Dr. Burr saw the latter case with him and found no evidence of spinal injury except the skin anæsthesia previously noted. Both patients made good recoveries and have good use of their limbs. He had seen both within a year. They walk perfectly well, although they still have marked kyphosis in the lumbar region at the site of injury and have slight rigidity of the spine in bending. Otherwise their conditions are excellent.

CASE OF HERMAPHRODITISM

DR. FRANCIS OLCOTT ALLEN gave the history of a second patient, a woman of forty-three, unmarried, an inmate of the Insane Department for many years, suffering from dementia præcox. Double inguinal hernia had been present since infancy. She had never menstruated, and vaginal examinations, the first when she was fourteen years old, showed that neither cervix nor uterus was palpable. When Dr. Allen saw her, on June 25, 1915, she had been ill for two days with an attack of vomiting and apparent abdominal discomfort. Her mental condition was such that it was not possible to be sure of her subjective sensations. She had had similar attacks before, but none so severe as the present one.

CASE OF HERMAPHRODITISM

On examination there seemed to be tenderness in the lower right abdomen, but whether its seat was in the inguinal or the appendiceal region could not be determined. There was no muscular rigidity, nor was any hernia discoverable in her recumbent position. Her temperature was 101° and there was a leucocytosis of 17,000; 86 per cent. polymorphonuclear. He operated upon her the same day, removing a normal-looking appendix, which was later reported to show, microscopically, a chronic inflammation. On exploring the pelvis, no uterus, tubes, or ovaries could be found. At each internal ring there was a small body about the size of an ovary. His incision was through the right rectus, so that he could do no more than determine the presence of such a body on the left side. The one on the right side slipped readily in and out of the ring and was evidently the content of the hernia. He decided to remove this organ in order to prevent the recurrence of the hernia, and in doing so found that it was retroperitoneal; that extending from it into the inguinal canal there was a band of tissue; that a duct-like cord ran retroperitoneally toward the midline; and that another duct-like structure, also retroperitoneal, passed upward, under the cæcum, toward the kidney. There were no signs of peritoneal inflammation, past or present, and these three attachments were not adhesions but definite structures. The peritoneum was divided, the three structures mentioned ligated and cut, and the organ removed. The peritoneum was sutured over the uncovered surface and the abdominal wound closed.

The patient recovered and returned to the Insane Department, where she still is. She has not had any attacks of vomiting, such as she formerly had, and is physically well. Her mental state is unchanged.

The organ removed is described by Dr. Orton, of the Laboratory of the Insane Department, as follows:

Specimen consists of a mass of tissue of irregular form partially covered with serous membrane and made up of two closely associated masses. One of these is a roughly oval mass about 2.5 by 1.7 by 1.6 cm. in size and closely associated with a larger, more irregular, mass. Partly encircling the smaller mass and attached to it at either end is a cord-like or tubular structure varying in diameter from 2 to 6 mm.

Gross Appearance.—On section the smaller oval mass has a whitish, coarsely granular appearance, characteristic of a section of testicle, while the mass below shows numerous large vessels and a moderate amount of rather intense congestion.

Microscopic Examination.—Small pieces of the smaller mass fixed in Zenker's fluid and in formalin. Remainder fixed *in toto* in Kaizerling.

Zenker fixation, paraffin sections, eosin and methylene blue stain: Section is covered on one side by heavy fibrous tissue capsule. Main portion is made up

of tubular structures between which lie many close-packed masses of cells. The tubules are made up of light connective-tissue strands, containing, for the most part, loosely grouped, rather indefinitely formed cells with relatively few and rather small nuclei. In many instances the tubules are more or less filled with this material; in others, it forms a distinct parietal zone surrounding a lumen and with a general radial arrangement of protoplasm and nuclei.

In general, the microscopic picture of this section conforms entirely with that of a cryptorchid testis from a male or with the advanced stages of testicular atrophy seen as a result of hypophysectomy, in both of which there is complete or almost complete absence of cells of the spermatogenic series, but with the preservation of the tubular connective-tissue reticulum, in whose lumina lie the more or less altered remains of cells, which probably represent the sustentacular cells of Sertoli, and with a striking complement of the interstitial cells of Leydig.

This histologic diagnosis is borne out by the anatomic relations I have described—the gubernaculum passing ahead of the testicle into the inguinal canal and the vas deferens inward toward the seminal vesicles behind the rectum. The other duct-like structure running toward the kidney can be explained by assuming a persistent embryonic Müller's duct.

An examination of the patient's external genitalia and secondary sexual characters showed no evidence of even a tendency to masculinity. The bony frame was small; the distribution of hair typically feminine; the breasts as well developed as those of normal single women of the same age and build; the vulva, nymphæ, and urethra normal in appearance; the vagina of fair size, ending in a blind pouch; the clitoris not enlarged.

On the accepted theory that the internal secretion of the genital gland is the determining factor in the secondary sexual manifestations, this individual would be expected to be masculine in type. The only way to account for the findings as they are is to assume that ovarian tissue is also present and functionally predominant. It may be that the organ at the left ring is an ovary, though it seemed at operation precisely like the one removed. Or there may be ovarian tissue elsewhere, which was not found at operation. There are other cases recorded in which both testicular and ovarian tissues were present.

This patient's family history is very curious in connection with her own genital anomaly, and suggests a possible hereditary factor in her case. Her maternal grandmother was one of a large family, among whom two married sisters had no children. Her mother was one of



FIG. 7.—Fracture of tuberosity of scaphoid of foot by muscular action.

FRACTURE OF FOOT BY MUSCULAR ACTION

seven sisters and two brothers. Of these, three sisters never menstruated. One of the three was examined some years ago and was found to have "testicles." What such a report means is, of course, uncertain, but it indicates some anomalous condition. The patient herself is the only abnormal member of her immediate family, both of her sisters having normal menstruation, and one of them a normal child.

FRACTURE OF THE TUBEROSITY OF THE SCAPHOID OF THE FOOT BY MUSCULAR ACTION

DR. GEORGE ERETY SHOEMAKER described an unusual variety of injury which simulates a sprain of the foot, but in reality is a more serious lesion. The patient was a normal young woman of thirty years, lately convalescent after a pregnancy, but otherwise well. The injury was occasioned by so slight an application of force as stepping from an automobile to the pavement, where a slight irregularity turned the foot, clad in a light, low shoe. She fainted with the pain and fell, but only after the injury; consequently, the injury was due to muscular action. An ordinary adhesive plaster dressing of strips, alternating in direction, applied by the Gibney method, proved intolerable, causing pain from pressure under the inner side of the arch of the foot, where was the point of greatest tenderness. Another dressing was applied with like result. Crepitus was not obtainable, perhaps on account of swelling. The X-ray showed that the tuberosity of the scaphoid was broken off or separated, the fragment being a half inch in thickness and not a scale. By comparison with the normal scaphoid of the other foot, the slight displacement and the line of separation are seen very distinctly.

A question arises as to whether this was a fracture or a separation of the tuberosity, because Piersol (Anatomy, page 425) says that the end of the knob of the tuberosity is sometimes distinct from the scaphoid and is then known as the *tibiale externum*.

Spalteholz does not mention any such anomaly, nor does Cunningham or Quain; moreover, anomalies of this type tend to be bilateral if present, but here the other scaphoid is all in one piece.

The main portion of the tendon of the *tibialis posticus* muscle is inserted in this tuberosity and it is easy to understand the powerful force brought to bear by a misstep upon this support of the arch of the foot. I believe the condition to have been one of fracture of the scaphoid. If unrecognized by the X-ray, and therefore not treated by fixation for a sufficiently long time, the disability from such an injury

PHILADELPHIA ACADEMY OF SURGERY

would likely be lasting, because the tibialis posticus would move the fragment and prevent union.

A plaster-of-Paris dressing gave immediate relief from pain. The treatment was that of fracture. Convalescence was normal, but it was a year and a half before occasional discomfort failed to be felt under strain.

EXPERIMENTAL COLONIC STASIS

DRS. CHARLES H. FRAZIER and MAX M. PEET read a paper with the above title, for which see page 729.

HIGH INTESTINAL STASIS

DRS. J. E. SWEET, MAX M. PEET, and B. M. HENDRIX read a paper with the above title, for which see page 720.

DR. JOHN H. JOPSON said that surgeons had long noted that the poison responsible for the fatal results in cases of acute intestinal obstruction was much aggravated in its action both by the anæsthetic and by operations for the relief of the obstruction when the bowel was not drained externally. Cases of intestinal obstruction may come to the operating table in fair condition, and shortly after anæsthesia is begun, and also after the liberation of the obstruction, the patient will go down very rapidly. The advantages of enterotomy and enterostomy are well recognized, although there is still some difference of opinion as to the advisability of the formation of a fecal fistula. In cases of spontaneous establishment of fecal fistula, the rapidity of improvement is oftentimes most striking. Perhaps Dr. Sweet can say whether the sudden relief of the obstruction in the bowel is followed by rapid absorption in the hitherto distended portion, or does the absorption take place lower down after the obstruction is relieved?

Regarding the work of Drs. Frazier and Peet of reversal of the colon in the dog, he did not think this furnishes a thorough criterion of the conditions found in the human subject. Clinical experience has demonstrated that cases presenting marked ptosis of the large and small bowel, associated with constipation, are relieved and made more comfortable, as a rule, so long as the constipation is overcome by medicinal or operative measures. Almost any one of the several operations which have been recommended for intestinal stasis will give relief, temporary perhaps, but still marked for the time. One should not, therefore, discard the whole theory of intestinal stasis in its relation to colonic absorption on the testimonial of experimental work alone, when it is strongly controverted by clinical experience.

HIGH INTESTINAL STASIS

DR. A. E. TAYLOR said that there are four obvious possibilities in the intoxication to be observed in high intestinal obstruction and in colonic stasis:

Intoxication by retention of toxic substances secreted by or formed in the glands of the digestive apparatus and the intestinal mucosa.

Intoxication by absorption of half-way stages of protein or lipid digestion, or by abnormal intermediary stages.

Intoxication by products of bacterial action on the products of the digestion of protein or lipid.

Intoxication by specific bacterial poisons, in really representing specific infectious processes.

It is likely that many so-called gastro-intestinal intoxications are in reality specific bacterial infections involving the alimentary tract, but the bacteriology of the fæces is in such a state of confusion that it has not been possible to isolate and identify the pathogenic organism in accordance with established procedures.

Intoxications under factors one and two may reasonably be restricted to high intestinal obstruction; intoxication under factor three may reasonably be restricted to colonic stasis.

Bacteria operating, in the colon largely, upon the end-products of protein digestion seem to display, in accordance with the characteristics of the particular flora, three directions of reaction: direct reduction, leading to the splitting off of ammonia and the conversion of the amino-acid back to the corresponding fatty acid; hydrolysis, with splitting off of ammonia, and leading to the corresponding hydroxy-acid; and the so-called carboxylase reaction, carbon dioxide being split off and the corresponding amine formed. It seems reasonable to infer that certain flora react in the one direction, other flora in another. The formation of amines tends to the production of substances likely to have toxic properties, especially the amines of the basic histone bodies, which exist in nature in the ergot, and one of which, imidazoethylamine, is very toxic. It is clear, both from the results of these experiments and from clinical experiences, that mere retention of normal stools in the colon, under certain conditions of bacterial activity, need not necessarily lead to the formation of toxic substances. The exact toxic cause of the symptoms in high intestinal obstruction has not been established.

DR. SWEET, in reply to Dr. Jopson, said that it has been found that substances such as strychnia are absorbed with difficulty from the obstructed loop. It has been found that the specific poison of high obstruction is not absorbed from the normal intestine. Nevertheless,

there is clinical evidence that the material above an obstruction can cause symptoms of intoxication if allowed to pass down the gut, and it should be noted that neither of the two experiments I have just mentioned actually corresponds to the clinical condition. The intestine below an obstruction is not necessarily a normal intestine, and it is conceivable that rapid absorption might take place, as, in fact it seems, occurs in clinical practice.

JEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY

DR. NATHANIEL GINSBURG read a paper with the above title, for which see page 732.

DR. JOHN H. JOPSON had had one case of ulcer at the stoma following gastro-enterostomy for perforation of a duodenal ulcer. The symptoms of ulcer had been present for ten years before perforation had taken place. At operation the perforation was found temporarily sealed by adhesions. It was sutured and a posterior gastro-enterostomy performed, using catgut for the inner and Pagenstecher for the outer sutures. The ulcer symptoms recurred about five and a half months after operation. There was hunger pain, paroxysmal in type, coming on especially in the afternoon and during the night, without vomiting. An area of tenderness was present just to the right of the middle line and between the ensiform cartilage and the umbilicus. Pain would begin over a small area and spread downward. The patient could not take any solid foods without pain. Liquid diet gave moderate relief. At operation, in July, 1914, the pylorus was found buried in adhesions and was not disturbed. There was a perforating ulcer at the gastro-enterostomy opening involving both stomach and jejunum, covered in by recent adhesions, not leaking but bleeding freely when exposed. It was 2 cm. in diameter. It was sutured and anastomosis performed between the proximal and the distal portions of the jejunum below the gastro-enterostomy opening.

This operation was not followed by permanent relief. There was marked hyperacidity of the gastric secretion subsequently and frequently blood present in considerable quantities in the stools. The patient was fairly well on liquid diet. When last seen he was better, but still suffering from ulcer symptoms.

DR. GEORGE G. ROSS mentioned a case in his service at the Germantown Hospital, a man upon whom he did a gastro-enterostomy for gastric ulcer. Two years after the operation the man came back to the hospital in the middle of the night with a perforated gastrojejunal

JEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY

ulcer. He was operated upon by Dr. Swartley. The case will be fully reported at a future meeting of the Academy.

DR. DAMON B. PFEIFFER recently saw a case which seems to throw some light upon the rôle of unabsorbable sutures in gastrojejunal ulcer. The case occurred in the service of Dr. Deaver and was that of a woman who at operation was found to have duodenal ulcer of chronic type. The ulcer was excised, the duodenum inverted and sewed to the denuded head of the pancreas, and a posterior gastrojejunostomy made. Following the operation the patient did pretty well for a couple of weeks. She then began to have epigastric pains as before the operation, and finally, after a downward course, during which she passed considerable blood from the bowel, she died. At autopsy, upon opening up the loop of jejunum just beneath the gastrojejunostomy, it was found that the outer seroserous suture, which was a continuous one of linen thread, was hanging in the bowel. Half had ulcerated out and half was retained. The inner layer of suture was chromic catgut and there was no trace of it. The in-turned end of the stomach which had been sutured in much the same way as the gastro-enterostomy, *i.e.*, with a linen suture outside and chromic gut within, showed much the same condition, and the linen thread was hanging part way in the lumen of the stomach. The condition was very suggestive; if the patient had lived, ultimately both sutures probably would have pulled out; but it is easy to suppose that such a suture in place for some time might set up chronic ulcer and be the foundation of gastrojejunal ulcer.

DR. J. EDWIN SWEET said that in the laboratory of surgical research they used silk for all coats of the intestines. They have seen many gastrojejunostomies with the silk sutures sloughing away with no evidence of ulcer forming about them. One can well imagine that silk thread in a gastric mucosa, which was, as evidenced by previous history, subject to ulcer formation, might be an added irritation, but one can hardly conceive of how silk thread alone in a normal mucosa could be held responsible.

DR. NATHANIEL GINSBURG said that with reference to the unabsorbable suture in relation to gastrojejunal ulcer, this is not the sole factor responsible for the development of this lesion. Chronic irritation at the line of union maintained by hyperacidity and the presence of the suture acting as a foreign body, in some cases, is the causative element in the production of the ulcer at the stoma site.

Lieblein supports the contention that hyperacid gastric contents plus the traumatism occasioned by the suture at the anastomosis site is a very important etiological factor. He quotes the work of Wilkie, of

Edinburgh, who, in his animal experimentation, used silk sutures and later fed the animals upon a hyperacid diet. He was able to produce jejunal and gastrojejunal ulcers in his animals, using a control set of cats to whom he did not feed hyperacid diet following operation, and in whom ulcer was not produced. It must be borne in mind, however, that the physiology of the gastro-intestinal path of the human and the lower animal type differs markedly, and that the nervous system which is such an important factor in the human plays little part in experimental work upon dogs and cats.

In a discussion some years ago, Cannon stated that he fed animals with shot whom he had gastro-enterostomatized without closure of the pylorus. His radiograph showed a shot with a string attached, having passed through the patent pylorus. He contended that the best functional result therefore occurs if the pylorus is occluded when gastro-enterostomy is done, thereby forcing all the gastric contents through the stoma.

Patterson replied that he was unable to speak from experimental work upon dogs, but he never fed his patients upon shot, inferring that the difference between human and animal surgery must always be borne in mind in making deductions when the final summary is drawn.

A NEW NEEDLE-HOLDER

DR. J. E. SWEET presented a needle-holder and said that his reason for attempting the design of a new instrument is to be found in the slightly unusual conditions surrounding the operative work in the Research Laboratory and in the fact that no instrument of which he had knowledge satisfactorily fulfilled these conditions. They have found from experience that their patients, since they will not be quiet after an operation, but will be as active as before, must have their wounds so repaired that the strain will be withstood. They have found that this can only be accomplished by the use of interrupted sutures in the layer of the wound which normally carries the chief strain—the aponeurosis layer in a midline wound, for instance—and these interrupted sutures must be laid not over one-eighth to one-quarter inch apart. Further, they must prepare their own suture material. The result of this is that they try to avoid the loss of time caused by the threading of many needles, and therefore adopt the technic of starting with a long thread, tying each suture as laid, thus saving time and suture material. With the common needle-holder this means that the suture is placed, the needle-holder laid down, the suture tied, scissors picked up, the suture cut, the scissors laid down, and the needle-holder taken

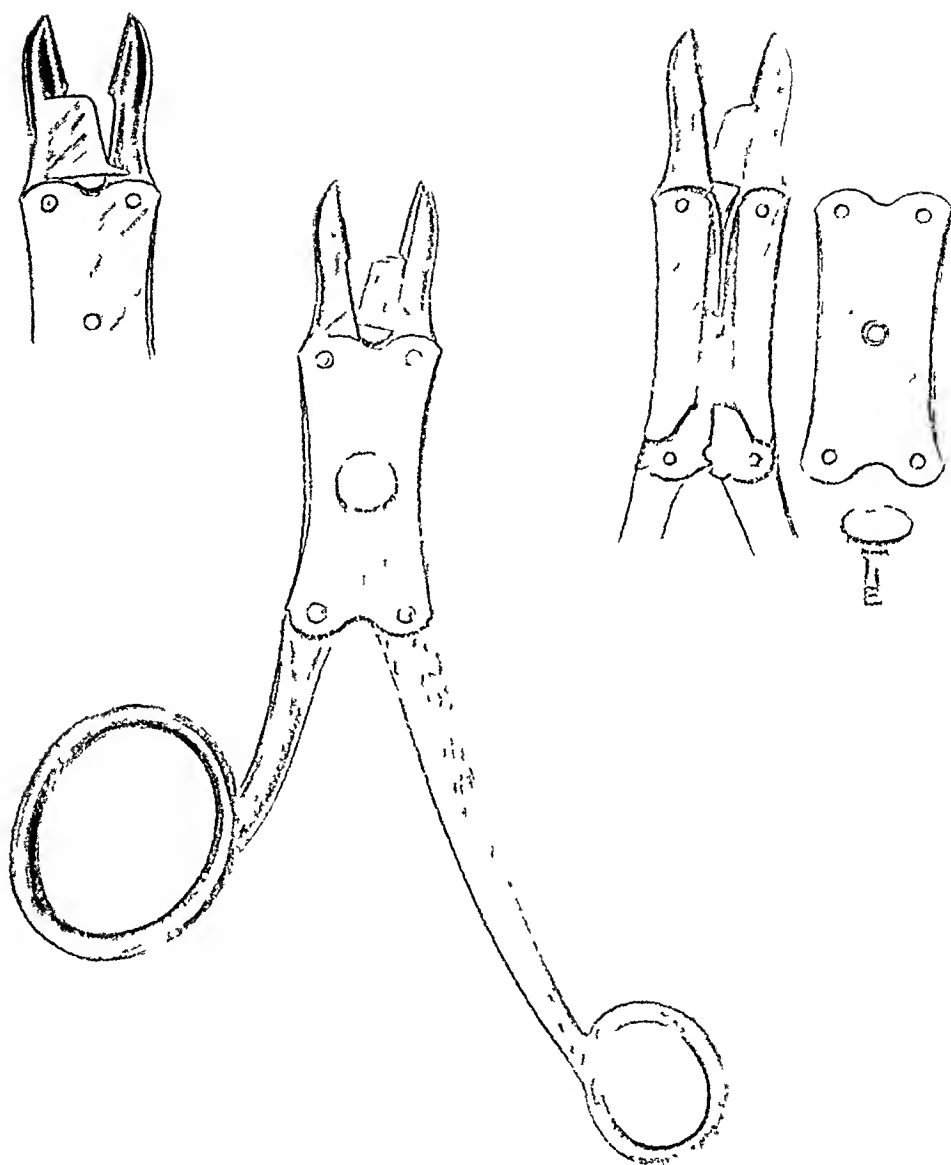


FIG. 8.—Sweet's needle-holder.

A NEW NEEDLE-HOLDER

up again. He therefore wanted a holder which could be held in the hand, and yet leave the thumb and fingers free for tying. This principle is found in the handles of the Kocher scissors. Since one of these handles is very short, and therefore permits of but short leverage, he introduced the principle of the double-lever joint, such as is used in powerful cutting implements, as bolt cutters, heavy wire cutters, etc.

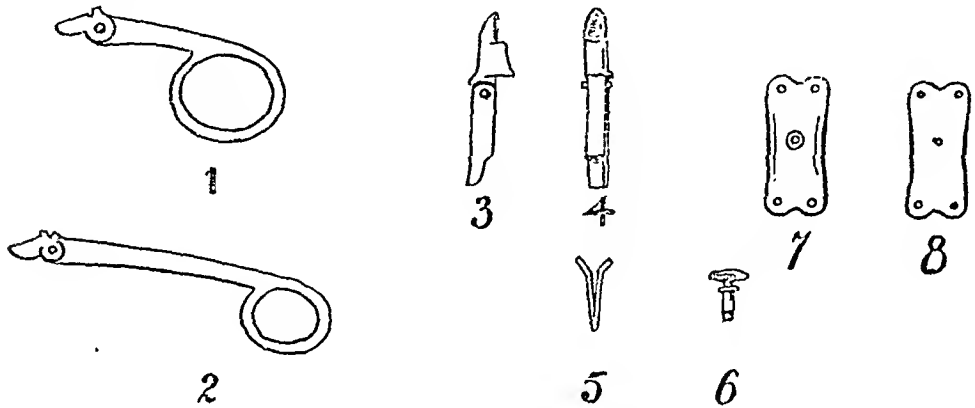


FIG. 9.—The component parts of needle-holder.

This gives great power at the jaw, and enabled him to dispense with any form of catch for the handles; a comparatively light pressure on the handles holds the needle firmly, and any form of catch, with the well-known troubles inherent to them, is unnecessary. The scissors attachment is not new in principle, nor is the form of the jaw. It is not unlikely that in this form of instrument, with the bearings supported at each end, the alignment of the scissors blades will be kept more perfect than in other types. By removing the one screw the entire mechanism comes apart for cleaning.

To Contributors and Subscribers:

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N. Y.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS of SURGERY

227-231 S. 6th Street

Philadelphia, Penna.

IN MEMORIAM

J. WILLIAM WHITE

SINCE January, 1892, nearly twenty-five years, the title page of the ANNALS OF SURGERY has borne the name of Dr. J. William White, of Philadelphia, as *one of its collaborating editors*. It is with profound grief and a deep sense of loss that we now have to record his death, which took place on April 24, after many months of disability and suffering. It will be the privilege of others to speak of the characteristics as a citizen, a teacher and a surgeon, which he displayed during the years of his active and laborious life. It is meet, however, that the ANNALS OF SURGERY should not allow the hour to pass without some record of the part which he played in its development. Our special relations began in the latter part of 1891 when, through his initiative and influence, this JOURNAL was acquired by the University of Pennsylvania Press, and its place of publication transferred from St. Louis to Philadelphia. He consented at that time to become one of the collaborators in the work of the JOURNAL and secured the further addition to its staff of Mr. Frederick Treves, of London, who was his intimate friend. When the proprietorship of the JOURNAL was taken over by the house of J. B. Lippincott Company, in 1897, Dr. White's interest in it still continued, and we have had the benefit of his advice and assistance until the hour of his death. Looking back over the past it is plain that the change in the home of the JOURNAL which occurred in 1892 had a great influence in opening up the possibilities in the field of surgical journalism which it has since been able to realize, so that all who are interested in it or are served by it should not fail to give to Dr. White credit for the result which he secured.

Of all the characteristics which Dr. White presented in so notable a degree none was more pronounced than that of loyalty to his friends and to the causes which he espoused. He was a tower of strength in whatever cause his interest was awakened. He was facile and quick in resource, broad and comprehensive in the fields of his endeavors and intense and unsparing of himself in his efforts to accomplish those ends which appealed to him as desirable.

LEWIS S. PILCHER.

INDEX TO VOLUME LXII

A

- Acidosis in Surgery, 385.
 Adhesions, Peritoneal, Their Prevention with Citrate Solutions, 198; 205.
 Albee on Bone Graft Surgery, Review of, 504.
 ALLEN, FRANCIS A.: Fracture of Lumbar Vertebrae Without Nerve Symptoms, 757.
 Amputation Stumps, 752.
 Anæsthesia Infiltration, A Method of Facilitating, 678; by Warmed Ether Vapor, 305.
 Aperiosteal Amputation Stump, 752; Stump and Its Care, 674.
 Apoplexy, Operative Steps Dealing With, 513.
 Appendicitis, Left-sided, Complicating Transposition of the Viscera, 124; Suppurative, the Prevention of Fecal Fistula in, 452.
 Appendix, Pathologic Diagnosis of Diseases of the, 697; Retrocæcal, The Treatment of, 715; Vermiform, Cystic Dilatation of the, 334.
 ARMITAGE, H. M.: Treatment of Injuries in the Vicinity of the Elbow-joint, 596.
 ASHHURST, ASTLEY P. C.: Congenital Malformation of the Extremities, 378; Hæmatoma of the Rectus Muscle, 245; Multiple Cartilaginous Exostoses (Hereditary Deforming Chondrodysplasia), 167; Perthes' Disease, 372.
 Astragalus, Fracture-Dislocation of the, 606.

B

- BALFOUR, DONALD C.: Non-Strangulated Diaphragmatic Hernia Due to Indirect Injury, 78.
 BARTLETT, WILLARD: A Method of Facilitating Infiltration Anæsthesia, 678.

- BEER, EDWIN: Hypernephroma, 630, 631; Immediate Reduction of Fractures, 635; Transperitoneal Nephrectomy for Tumor of the Kidney, 630.
 BEHAN, R. J.: Method of Correcting Stomach Dilatation in Gastropnoia, 541.
 Blood, Uncontaminated, Method of Obtaining, from Animals, 108.
 BOLLING, R. W.: Fractures of the Neck of the Scapula, 215.
 Bone Graft Surgery, Review of Albee on, 504; Surgery, Autoplastic, Review of Davidson and Smith on, 506; Transplantation, 242; Tumors, Giant-cell Medullary, Observations on, 454.
 BOORSTEIN, SAMUEL W.: A Symmetrical Congenital Malformation of the Extremities, 192.
 Brain, Bullet Retained in, 111; Bullet Wound of, 114; Endothelioma, Frontal Lobe, 380; Tumors, Cerebellar, The Localization of, 129.
 Branchiogenic Fistula, 519.
 Breast Cancer, Hypophysial Disorder in, 297; Tuberculosis of the, 668.
 BROMER, RALPH: Impressions of the Surgery of the European War, 252.
 Brophy's Oral Surgery, Review of, 639.
 BRYAN, ROBERT C.: Sigmoidovesical Fistula, 353.
 Bullet Retained in Brain, 111; Wound of Brain, 114; of Knee and of Popliteal Vein, 112.

C

- Cæcostomy for Mercuric Bichloride Poisoning, 127.
 Cancer of the Breast, Hypophysial Disorder in, 297.
 Cerebellar Tumors, The Localization of, 129.
 Cholecystostomy for Mercury Bichloride Poisoning, 127.

- Cholelithiasis, Intrahepatic, 535.
 Chondrodysplasia, Hereditary Deforming, 167.
 Chrome Sores, 155.
 Circulation of the Lower Extremity, Reversal of the, 277.
 Citrate Solutions for the Prevention of Peritoneal Adhesions, 198, 205.
 COHN, ISIDORE: Acute Dilatation of the Stomach Complicating Operations on the Extremities, 263.
 COLEY, WILLIAM B.: Primary Neoplasms of the Lymphatic Glands Including Hodgkin's Disease, 35.
 COLLINS, HOWARD D.: Immediate Application of Plaster-of-Paris Dressings in Fractures, 634.
 Colon, Giant, 349.
 Colonic Stasis, Experimental, 729.
 Congenital Malformation of Extremities, 378.
 CONNELL, KARL: Plaster - of - Paris Dressings for Fractures, 637.
 COTTON, FREDERIC J.: Artificial Impaction of Hip Fracture, 366.
 Crossen's Text-book of Operative Gynecology, Review of, 254.
 Cystectomy, Total, Condition One and One-half Years After, 754.
 Cystostomy, Suprapubic, in Badly Infected Cases, the Technic of, 686.
 Cysts Connected With Hernial Sacs, Etiology of, 544.
- D
- DA COSTA, JOHN CHALMERS: Tanners' Ulcer, 155.
 DARRACH, WILLIAM: Late Changes Following Bone Reduction of Fracture-dislocation of Shoulder, 746; Plea for the Immediate Reduction of Fractures, 593.
 Davidson and Smith, Autoplastic Bone Surgery, Review of, 506.
 DAVIS, BENJAMIN FRANKLIN: The Use of Warmed Ether Vapor for Anæsthesia, 305.
- DAVIS, GWILYM G.: Malformations of the Extremities, 379; Multiple Cartilaginous Exostoses, 250; Perthes' Disease, 372.
 DEAYER, JOHN B.: Operation for Removing the Gall-bladder, 415.
 Dental Plate in the Œsophagus, 672.
 Diabetes Insipidus, Relation of, to Hypophysial Disorder in Breast Cancer, 297.
 Diaphragmatic Hernia, Non-Strangulated, Due to Indirect Injury, 78.
 Dilatation of the Stomach, Acute, Complicating Operations on the Extremities, 263; of the Stomach, Acute Operative, 418.
 DODGE, GEORGE E.: Cystic Dilatation of the Vermiform Appendix, 334.
 DOUGLAS, JOHN: Bullet Retained in Brain, 117; Duodenal Ulcer, 744; Gastric Ulcer, 744; Operative Relief of Carcinoma of the Stomach, 112; Syphilis of the Stomach, 743.
 DOWN, CHAS. N.: Amputation Stumps, 752; Complete Branchiogenic Fistula, 519; Excision of Duodenal Ulcers, 745; Fracture-dislocation of Shoulder, 748; Obliterating Thromboangiitis Accompanying Lead Poisoning, 750.
 DOWNES, WILLIAM A.: Transperitoneal Nephrectomy, 632.
 Duodenal Ulcer, Pathogenesis of, 318.
 Duodenopyloric Fornix, Ulcer of the, 328.
 Duodenum, Anatomical and Physiological Subdivisions of the, 318.
 DURANTE, LUIGI: Tuberculosis of the Breast, 668; Tuberculosis of the Tongue, 143.
- E
- EASTMAN, JOSEPH R.: Toxicity of Novocaine-adrenalin Injected Intravenously, 619.
 Elbow-joint, Foreign Body in, 628; Treatment of Injuries in the Vicinity of the, 596.

INDEX

- ELIOT, ELLSWORTH: The Legal Responsibility to the Surgeon which the Use of the X-ray Involves, 479.
- ELMER, WALTER G.: Lumbar Hernia, 377.
- Endothelioma of Frontal Lobe of Brain, 380.
- Epigastric Artery, Repair of the Deep, 244.
- Ether Vapor, Warmed, Use of, for Anæsthesia, 305.
- European War, Remarks on the Surgery of the, 208.
- Exophthalmos, Pulsating, 389.
- Exostoses, Multiple Cartilaginous, 167, 250, 749.

F

- FALK, HENRY C.: The Surgical Anatomy of the Thyroids and the Parathyroid Glands, 71, 124.
- Fascial Bands, Inefficiency of Pyloric Exclusion by, 438.
- FAUNTLEROY, A. M.: Gas Bacillus Infection, 1.
- Femur, Fracture of the Neck of, Artificial Impaction for, 366; Fracture of the Neck of the, Rôle of Abduction in the Treatment of, 509.
- Fibula, Congenital Absence of the, 378.
- Fistula, Branchiogenic, 519; Fecal, in Suppurative Appendicitis, The Prevention of, 452; Sigmoidovesical, 353; Small Vesicovaginal, Repair of, 106; Vesicovaginal, Repair of, 512.
- FLINT, JOSEPH MARSHALL: The Treatment of Fractures by Suspension and Extension, 641.
- FLUMERFELT, GERTRUDE: Subdivisions of the Duodenum, 318.
- Foreign Bodies in the Respiratory Tract, 656; in the Small Intestine, 247; in the Tissues, The Significance of, 24, 113.
- Fracture of the Lower Extremity of the Radius, 240; of the Lumbar Vertebrae, Ununited, 374; of the Os Calcis, 237.
- Fracture-dislocation of the Astragalus, 606; of Shoulder, Late Changes Following Bone Reduction, 746.
- Fractures, Ambulant Treatment of, 634; of Humerus, Ununited, Transplantation of Bone in, 464; The Immediate Reduction of, 593; in Military Surgery, 641; of the Neck of the Scapula, 215; Shaft, Artificial Periosteum for Fixation of, 182; Straus's Method of Fixing, 253.
- FRAZIER, CHAS. H.: Experimental Colonic Stasis, 729.
- FREEMAN, LEONARD: Use of Free Omental Grafts in Abdominal Surgery, 83.

G

- Gall-bladder, Operation for Removing the, 415; Pseudo-diverticulum of, 627.
- Gall-stone Ileus, 248.
- Gangrene of the Extremities Due to Thrombo-angiitis Obliterans, Conservative Treatment of the, 280.
- Gas Bacillus Infection, 1.
- Gastrectomy for Carcinoma, Partial, III.
- Gastric Ulcer, 744.
- Gastro-enterostomy Followed by Jejunal Ulcer, 732, 764.
- Gastro-intestinal Tract, Röntgen Diagnosis of Surgical Lesions of the, Review of George and Leonard on, 255.
- Gastroptosis, Complicated by Stomach Dilatation, Method of Correcting, 541.
- George and Leonard's Atlas on the Röntgen Diagnosis of Surgical Lesions of the Gastro-intestinal Tract, Review of, 255.
- GIBSON, CHARLES LANGDON: Post-operative Intestinal Obstruction, 442.
- GILL, A. BRUCE: Surgical Tuberculosis Treated by the Rollier Sunshine Method, 251.
- GINSBURG, NATHANIEL: Fracture of the Os Calcis, 237; Jejunal Ulcer Following Gastro-enterostomy, 732; Relation of Unabsorbable Sutures of Gastrojejunal Ulcer, 765.

INDEX

- GOODMAN, CHARLES: Method for Obtaining Uncontaminated Blood from Dogs and Other Animals, 108.
 GOODMAN, EDWARD H.: Lumbar Hernia, 548.
 Grafts, Free Omental, Use of, in Abdominal Surgery, 83.
 GREEN, NATHAN W.: Foreign Bodies in the Respiratory Tract, 656; Stitch for Closing Posterior Sheath of the Rectus, 364.
 GREGOR, GILBERT D.: Dental Plate in the Œsophagus, 672.
 GREY, ERNEST G.: Studies on the Localization of Cerebellar Tumors, 129.
 GUADIANI, VINCENT: Surgical Treatment of Suppurations in Posterior Mediastinum, 523.
 GUTHRIE, DONALD: The Prevention of Fecal Fistula in Suppurative Appendicitis, 452.
 Gynæcology, Operative, Review of Crossen's Text-book of, 254.
- Hip-joint, Osteomyelitis Involving the, 473.
 HITZROT, JAMES MORLEY: Fractures of the Neck of the Scapula, 215.
 Hodgkin's Disease, 35.
 HORSLEY, J. SHELTON: Reversal of the Circulation in the Lower Extremity, 277.
 HUBBARD, JOSHUA C.: Megacolon, 349.
 Humerus, Ununited Fractures of the, The Transplantation of Bone in, 464.
 Hypernephroma, Nephrectomy, 630-631.

I

- Ileus from Gall-stones, 248.
 Immediate Reduction of Fractures, 593.
 Infiltration Anæsthesia, A Method of Facilitating, 678.
 Intestinal Obstruction, Post-operative, 442; Stasis, High, 720.
 Intestine, Foreign Bodies in the Small, 247.
 Intracerebral Hemorrhage, Spontaneous, Operative Steps Dealing With, 513.

J

- Hands and Field of Operation, A Simplified Pre-operative Treatment of the, 608.
 HAUSSLING, F. R.: Clinical and Pathological Observations on Giant-cell Medullary Bone Tumors, 454.
 HENDERSON, MELVIN S.: The Transplantation of Bone in Ununited Fractures of the Shaft of the Humerus, 464.
 HENDRIX, B. M.: High Intestinal Stasis, 720.
 Hernia, Diaphragmatic, 78; Lumbar, 377, 548.
 Hernial Sacs, Etiology of Cysts Connected With, 544.
 HEWSON, ADDINELL: Needles in the Spinal Cord, 248.
 Hip-dislocation Mistaken for Fracture, 638.
 Hip-fractures, Artificial Impaction of, 366; the Rôle of Abduction in the Treatment of, 509.
- Jaksch's Anæmia, Splenectomy for, 122.
 JEFFERSON, GEOFFREY: Subdivisions of the Duodenum, 318; Ulcer of the Duodenopyloric Fornix, 328.
 Jejunal Ulcer Following Gastro-enterostomy, 732, 764.
 JONES, JOHN F. X.: Tanners' Ulcer, 155.
 JOPSON, JOHN H.: Experimental Colonic Stasis, 762; Fracture of the Capitulum of the Humerus, 629; Gall-stone Ileus, 248; Ulcer at the Stoma Following Gastro-enterostomy, 764.

K

- KAMMERER, FREDERIC: Protection of Parathyroids During Thyroidectomy, 125.
 KEENE, FLOYD E.: Repair of the Deep Epigastric Vein, 245.

INDEX

KENYON, JAMES H.: Bullet Wound of Knee and of Popliteal Vein, 112; Tendon and Nerve Suture After Wrist Wounds, 119.
Kidney, Congenital Mixed Tumor of the, Transperitoneal Nephrectomy for, 630.
Knee, Bullet Wound of, 112.

L

Lead Poisoning Accompanied by Ob-
literating Thrombo-angiitis, 750.
LEE, BURTON J.: Acute Operative Dila-
tation of the Stomach, 418; Effects
of Foreign Bodies in the Abdominal
Cavity, 117.
Leg, Perforating and Varicose Ulcers
of the, 561.
LEWALD, LEON T.: Foreign Bodies in
the Respiratory Tract, 656.
LEWISOHN, RICHARD: Intrahepatic
Cholelithiasis, 535.
LILIENTHAL, HOWARD: Ambulant Treat-
ment of Fracture, 634; Hyperne-
phroma With Secondary Growths,
Treatment of, 633; Treatment of
Cases of Fracture-dislocation of
Shoulder, 747.
Liver, Calculi in the Substance of the,
535.
LONG, JOHN WESLEY: Shirring the
Round Ligaments, 691.
LOWER, WILLIAM E.: Removal of Bul-
let from Pericardium, 533.
Lumbar Hernia, 377, 548; Vertebra,
Fracture of First, Without Nerve
Symptoms, 757.
LYLE, H. H. M.: The Aperiosteal
Stump, 674; Left-sided Appendicitis
Complicating Transposed Viscera,
124; Tuffier Splint for Drop-wrist,
120; Wounds Complicated by Re-
tained Foreign Bodies, 113.
Lymphatic Glands, Primary Neoplasms
of the, 35.

M

MACCARTY, WILLIAM C.: Tuberculosis
of the Breast, 668.

Malformation of the Extremities, A
Symmetrical Congenital, 192.
Mammary Cancer, Hypophysial Dis-
order in, 297.
MARTIN, WALTON: Aperiosteal Flaps,
753; Bullet Retained in Brain, 111;
Infections Occurring About Retained
Foreign Bodies, 118; Partial Gas-
trectomy for Carcinoma, 111; The
Significance of Foreign Bodies in the
Tissues, 24.
MARTLAND, H. S.: Clinical and Patho-
logical Observations on Giant-cell
Medullary Bone Tumors, 454.
MATHEWS, FRANK S.: Calculi in the
Submaxillary Gland and Wharton's
Duct, 140.
MAYO, CHARLES H.: Repair of Small
Vesicovaginal Fistula, 106.
McCARTY, FRANKLIN B.: The Use of
Warmed Ether Vapor for Anæsthe-
sia, 305.
McKNIGHT, H. A.: Fracture of the
Lower Extremity of the Radius, 240.
McWILLIAMS, CLARENCE A.: Homo-
plastic Transplantation of a Boiled
Radius, 185.
Mediastinum, Posterior, Surgical
Treatment of Suppurations in, 523.
Megacolon, 349.
Mercury Bichloride Poisoning, Chole-
cystostomy and Cæcostomy for, 127.
MEYER, WILLY: Cases of Bullet Re-
tained in Brain, 114; The Conserva-
tive Treatment of Gangrene of the
Extremities Due to Thrombo-angiitis
Obliterans, 280.
MILLIKEN, SETH M.: Hip Dislocation
Mistaken for Fracture, 638; Imme-
diate Treatment of Fractures, 637.
MOORE, JAMES E.: Osteomyelitis In-
volving the Hip-joint, 473.
MORRIS, ROBERT T.: Tolerance of
Foreign Bodies by Tissues, 115.
MOSCHCOWITZ, ALEXIS V.: Multiple
Cartilaginous Exostoses, 749.
MOSCHCOWITZ, ELI: Pathologic Diag-
nosis of Diseases of the Appendix,
697.

INDEX

- MOULLIN, C. MANSELL: The Classification of Tumors, 257.
MURRAY, R. W.: The Etiology of Cysts Connected with Hernial Sacs, 544.

N

- NASSAU, CHARLES F.: Carcinoma of Undescended Testicle, 627; Endothelioma of Frontal Lobe, 380.
Needle-holder, New, 766.
Nephrectomy for Hypernephroma, 630-631; Transperitoneal, for Congenital Mixed Tumor of the Kidney, 630.
Nerve Suture After Wrist Wound, 119.
NEUHOF, HAROLD: The Inefficiency of Pyloric Exclusion by Fascial Bands, 438.
NEW YORK SURGICAL SOCIETY, Transactions of the, 111, 119, 486, 491, 630, 743, 750.
New York University Laboratory Studies in Surgical Pathological Physiology, Review of, 508.
Novocaine-adrenalin Injected Intravenously, Toxicity of, 619.

O

- Obstruction, Post-operative Intestinal, 442.
Oesophagus, Dental Plate in the, 672.
Omental Grafts, Free, Use of, in Abdominal Surgery, 83.
Omentum, Torsion of the, 248.
Oral Surgery by Truman W. Brophy, Review of, 639.
Os Calcis, Fracture of the, 237.
Osteochondritis Deformans Juvenilis, 372.
Osteomyelitis Involving the Hip-joint, 473.
OWEN, HUBLEY: Bone Transplantation, 242.

P

- Parathyroid Glands, Surgical Anatomy of the, 71, 124.
PECK, CHARLES H.: Protection of Parathyroid Glands in Thyroidectomy, 125.

- PEET, MAX M.: Experimental Colonic Stasis, 729; High Intestinal Stasis, 720.

Penis for Carcinoma, Amputation of, Condition Four and One-half Years After, 755.

Pericardium, Removal of Bullet from, 533.

Periosteum, Artificial, for Fixation of Shaft Fractures, 182.

Peritoneal Adhesions; Their Prevention With Citrate Solutions, 198, 205.

Perthes' Disease, 372.

PETERKIN, G. S.: Calcareous Degeneration of the Prostate Gland, 681.

PFEIFFER, DAMON B.: Rôle of Unabsorbable Sutures in Gastrojejunal Ulcer, 765.

PHILADELPHIA ACADEMY OF SURGERY, Transactions of the, 237, 251, 372, 627, 754.

Physiology, Studies in Surgical Pathological, from the Laboratory of Research of New York University, Review of, 508.

PIPER, EDMUND B.: Remarks on the Surgery of the European War, 208.

Plaster-of-Paris Dressings in Fractures, Immediate Application of, 634.

POOL, EUGENE H.: Splenectomy for Jaksch's Anæmia, 122; The Surgical Anatomy of the Thyroid and the Parathyroid Glands, 71, 124; Tolerance of Foreign Bodies by Tissues, 115.

Popliteal Vein, Bullet Wound of, 112.

PRICE, GEORGE E.: Endothelioma of Frontal Lobe, 380.

Prostate Gland, Calcareous Degeneration of the, 681.

Pyloric Exclusion by Fascial Bands, the Inefficiency of, 438.

Q

QUILLIAN, GARNETT W.: Acidosis in Surgery, 385.

R

Radius, Fracture of the Lower Extremity of the, 240; Homoplastic Transplantation of, 185.

INDEX

- RANDALL, ALEXANDER: Results of Operations for Cancer of Penis, 756.
Rectus Muscle, Hæmatoma in the Sheath of the, 244; Stitch for Closing Posterior Sheath of, 364.
Removal of Bullet from Pericardium, 533.
REMSEN, CHARLES M.: Operative Steps Dealing With Spontaneous Intracerebral Hemorrhage, 513.
Respiratory Tract, Foreign Bodies in the, 656.
Retrocæcal Appendix, The Treatment of, 715.
Reversal of the Circulation in the Lower Extremity, 277.
RHODES, GOODRICH B.: Pulsating Exophthalmos, 389.
ROBERTS, JOHN B.: The Artificial Periosteum for Shaft Fractures, 182; Fracture of the Lower End of the Radius, 241; Straus's Method of Fixing Fractures, 253.
ROBINSON, ERNEST F.: Fracture-dislocation of the Astragalus, 606.
ROCKEY, A. E.: Double Uterus and Vagina, Operation for the Correction of, 615.
ROGERS, ALLEN: Toluol as a Storing Fluid for Catgut, 312.
ROGERS, JOHN: Surgical Anatomy of the Thyroid and the Parathyroid Glands, 124.
Rollier Sunshine Method for Treating Surgical Tuberculosis, 251.
Röntgen Diagnosis of the Surgical Lesions of the Gastro-intestinal Tract, Review of George and Leonard on, 255.
ROSENBERGER, RANDLE C.: Tanners' Ulcer, 155.
ROSS, GEORGE G.: Foreign Body in Elbow-joint, 628; Foreign Bodies in the Small Intestine, 247; Gastrojejunal Ulcer After Gastro-enterostomy, 764; Pseudo-diverticulum of Gall-bladder, 627; Torsion of the Omentum, 248.
Round Ligaments, Shirring the, 691.
- S**
- Scaphoid of the Foot, Fracture of the, 761.
Scapula, Fractures of the Neck of the, 215.
SEKIGUCHI, SHIGEKI: Hypophysial Disorder in Mammary Cancer, 297.
SHAW, HARRY A.: The Treatment of Retrocæcal Appendix, 715.
Shirring the Round Ligaments, 691.
SHOEMAKER, G.: Fracture of the Tuberosity of the Scaphoid of the Foot, 761.
Shoulder, Fracture-dislocation of the, Late Changes Following Reduction of, 746.
Shoulder-joint, Recurrent Dislocation of the, 375.
SHROPSHIRE, C. W.: Urethroplasty, 693.
Sigmoid, Rupture of the, by Inflation of the Rectum, 376.
Sigmoidovesical Fistula, 353.
SITER, E. H.: Results of Operations for Cancer of the Penis, 756.
SKILLERN, PENN G.: Treatment of Varicose Leg Ulcers, 176.
SLOCUM, MORRIS A.: Pre-operative Treatment of the Hands and Field of Operation, 608.
SMITS, J. C. J. C.: Perforating and Varicose Ulcers of the Leg, 561.
SPEESE, JOHN: Hæmatoma in the Sheath of the Rectus Muscle from Rupture of the Deep Epigastric Artery, 244; Lumbar Hernia, 548.
Spinal Cord, Needles in the, 248.
Splenectomy for Jaksch's Anæmia, 122.
Splenic Vessels, Ligation of, as a Substitute for Splenectomy in Blood Diseases, 88.
Splenomegaly, Acute Secondary Tuberculous, 315.
Stasis, Experimental Colonic, 729; High Intestinal, 720, 762.
Stewart's Manual of Surgery, Review of, 507.

INDEX

Stomach, Acute Dilatation of the, Complicating Operations on the Extremities, 263; Acute Operative Dilatation of the, 418; Carcinoma of, Partial Gastrectomy for, 111; Syphilis of the, 743.
 Stomach-dilatation in Gastroptosis, Method of Correcting, 541.
 Stump, Aperiosteal, and Its Care, 674.
 Submaxillary Gland and Wharton's Duct, Calculi in the, 140.
 Sunshine Method of Treating Tuberculosis, 251.
 Suprapubic Cystostomy in Badly Infected Cases, the Technic of, 686.
 Surgery, Stewart's Manual of, Review of, 507.
 Suspension and Extension in the Treatment of Fractures, 641.
 Sutures, Unabsorbable, Rôle of, in Gastrojejunal Ulcer, 765.
 SWEET, J. EDWIN: A New Needleholder, 766; High Intestinal Stasis, 720, 762; Material for Intestinal Sutures, 765.
 Syphilis of the Stomach, 743.

T

Tanners' Ulcer, 155.
 Tarsal Scaphoid, Fracture of the, 761.
 TAYLOR, A. E.: Intestinal Stasis, 763.
 Tendon Suture After Wrist Wound, 119.
 Testicle, Undescended, Carcinoma of, 627.
 THOMAS, B. A.: Amputation of Penis for Carcinoma, Condition Four and One-half Years After, 755; Total Cystectomy, Condition One and One-half Years After, 754.
 Thrombo-angiitis, Obliterating, Accompanying Lead Poisoning, 750; Causing Gangrene of the Extremities, The Conservative Treatment of, 280.
 Thyroid, The Surgical Anatomy of the, 71, 124.
 Toluol as a Storing Fluid for Catgut, 312.
 Tongue, Tuberculosis of the, 143.

Transplantation of Bone, 242; of Bone in Ununited Fractures of Humerus, 464; Homoplastic, of a Boiled Segment of a Radius, 185.
 Transposition of Viscera With Left-sided Appendicitis, 124.
 TROELL, ABRAHAM: Ligation of Splenic Vessels as a Substitute for Splenectomy in Blood Diseases, 88.
 Tuberculosis of the Breast, 668; Surgical, Treated by the Sunshine Method, 251; of the Tongue, 143.
 Tuberculous Splenomegaly, Acute Secondary, Treated by Splenectomy, 315.
 Tumors, The Classification of, 257.

U

Ulcer, Tanners', 155.
 Ulcers of the Leg, Perforating and Varicose, 561; Varicose, of the Leg, Treatment of, 176.
 Urethroplasty, 693.
 Uterus, Double, Operation for the Correction of, 615.

V

Varicose Ulcers of the Leg, 561.
 Vertebra, Fracture of First Lumbar, Without Nerve Symptoms, 757.
 Vertebrae, Ununited Fracture of the Lumbar, 374.
 Vesicovaginal Fistula, Small, Repair of, 106.
 VOSBURGH, ARTHUR S.: Immediate Application of Plaster-of-Paris Dressings After Fractures, 634.

W

War, European, Remarks on the Surgery of the, 208.
 WATTERSTON, CHAS.: Urethroplasty, 693.
 WHARTON, HENRY R.: Cases of Fracture of the Lumbar Vertebrae Without Symptoms of Spinal Injury, 758.
 Wharton's Duct, Calculi in the Submaxillary Gland and, 140.

INDEX

- WHITING, A. D.: Pre-operative Treatment of the Hands and Field of Operation, 608; Rupture of the Sigmoid by Inflation Through the Rectum, 376.
- WHITMAN, ROYAL: The Rôle of Abduction in the Treatment of Hip Fractures as Compared With Artificial Impaction, 509.
- WIENER, JOSEPH: Starch and Veneer Bandages for Fractures, 635.
- WIGHT, J. SHERMAN: Acute Secondary Tuberculous Splenomegaly, 315.
- WILLIAMS, HADLEY: The Technic of Suprapubic Cystostomy in Early Infected Cases, 686.
- WOOD, ALFRED C.: Case of Gall-stone Ileus, 250.
- Wounds Complicated by Retained Foreign Bodies, 113.
- Wrist-drop, Tuffier Splint for, 120.
- Wrist Wounds, Tendon and Nerve Suture After, 119.
- X**
- X-ray, Legal Responsibility in the Use of the, 479.
- Y**
- YOUNG, JAMES K.: Cases of Perthes' Disease, 372; Recurrent Dislocation of the Shoulder-joint, 375; Ununited Fracture of the Lumbar Vertebrae, 374.

